Uranium and Thorium Deposits in East-Central Idaho Southwestern Montana

GEOLOGICAL SURVEY BULLETIN 988-H

Uranium and Thorium Deposits in East-Central Idaho Southwestern Montana

By ALBERT F. TRITES, JR., *and* EDWIN W. TOOKER

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

GEOLOGICAL SURVEY BULLETIN 988-H

This report concerns work done on behalf of the U. S. Atomic Energy Commission and is published with the permission of the Commission

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1953

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 35 cents (paper cover)

CONTENTS

ILLUSTRATIONS

TABLES

CONTRIBUTIONS TO THE GEOLOGY OF URANIUM

URANIUM AND THORIUM DEPOSITS IN EAST-CENTRAL IDAHO AND SOUTHWESTERN MONTANA

By ALBERT F. TRITES, JR., and EDWIN W. TOOKER

ABSTRACT

In 1950, 39 mines and prospects in east-central Idaho and southwestern Montana were examined radiometrically by the Geological Survey to determine the grade, reserves, and mode of occurrence of uranium and thorium.

The region is underlain by granite gneiss of older pre-Cambrian age; metasedimentary rocks of younger pre-Cambrian age; limestone, dolomite, quartzite, sandstone, shale, and phosphate rock of Paleozoic and Mesozoic age; and shale, sandstone, and unconsolidated deposits of Tertiary age. The igneous rocks, which vary widely in composition, comprise pre-Cambrian and Cretaceous or Tertiary dikes, late Mesozoic batholiths, and Tertiary to Recent lavas. The rocks have been folded by pre-Cambrian, Laramide, and post-Miocene deformation and displaced by many thrust and normal faults.

Uranium occurs principally in gold, lead, copper, and quartz-hematite veins that cut pre-Cambrian quartzite and phyllite of the Belt series and Paleozoic limestone and shale. The uranium minerals that have been identified, torbernite and autunite, are associated with pyrite, galena, malachite, and hydrous iron oxides. These deposits are estimated to contain 0.02 to 0.1 percent uranium. Known reserves are small.

Thorium occurs in significant amounts in three copper-bearing veins and in at least nine quartz-hematite veins. One copper-bearing vein is in pre-Cambrian hornblende gneiss; the other veins cut argillite, sandstone, quartzite, and schist of the Belt series. The thorium occurs principally as thorite and as hydrothorite (?). The thorite is in very small, altered, red-brown, prismatic crystals associated with hematite, hydrous iron oxides, and barite. The hydrothorite (?) is believed to occur in the mixture of hydrous iron oxides. Minor quantities of monazite and allanite are found in some of the deposits, but they are not considered significant sources of thorium. These deposits are believed to contain 0.1 to 1.2 percent thoria (ThO_2).

INTRODUCTION

Many occurrences of uranium and thorium have been reported from ore deposits in east-central Idaho and southwestern Montana, but little production has come from the area.

Reconnaissance examinations for uranium were made in 1949 in Idaho and Montana by Vhay,[1] in Idaho by Anderson [2] and Adams

[1] Vhay, J. S., 1950, Reconnaissance examination for uranium at six mines and properties in Idaho and Montana: U. S. Geol. Survey Trace Elements Memo. Rept. 30.

[2] Anderson, F. J., 1950, Radiometric reconnaissance in the vicinity of Salmon, Idaho: U. S. Geol. Survey Trace Elements Memo. Rept. 26.

and King,[3] and in Montana by Klepper.[4] Detailed studies have been made in Idaho (Thurlow and Wright, 1950), in the Clancey area, Montana (Roberts and Gude, U. S. Geol. Survey Bull. in preparation), and in the Boulder area, Montana (Roberts and Gude, U. S. Geol. Survey Bull. in preparation, and Thurlow and Reyner[5]).

From July 11 to October 17, 1950, reconnaissance investigations for uranium on behalf of the U. S. Atomic Energy Commission were made by the U. S. Geological Survey of 39 mines and prospects in 7 districts (fig. 39) in Lemhi and Scott Counties, Idaho, and in Beaverhead, Silver Bow, and Madison Counties, Mont. Some of these deposits were examined because of promising analyses of samples submitted by property owners to the Geological Survey. All are described in this report for comparative purposes, even though some of the deposits examined do not contain radioactive minerals.

Surface and underground exposures at all mine properties visited were examined radiometrically with a 6-inch Geiger counter. Samples were collected from the radioactive deposits, and 69 of these samples have been analyzed for uranium by the Geological Survey Trace Elements Section Denver Laboratory. Significant deposits were mapped by pace-and-compass or plane-table-and-telescopic alidade methods at scales ranging from 1 inch equals 20 feet to 1 inch equals 50 feet.

Car-borne radiometric road logs were made of all roads traversed during field work in the mining districts studied. A survey meter, with two Geiger tubes, 40 inches long by 2 inches in diameter, connected in parallel and mounted on the top of a pickup truck, was used in the radiometric road logging.

The writers are indebted to the mine and prospect owners for their assistance in facilitating these studies.

GEOLOGY

SEDIMENTARY AND METAMORPHIC ROCKS

Pre-Cambrian rocks, which consist of granite gneiss overlain by metamorphosed sedimentary rocks, crop out over large areas in the mountain ranges of east-central Idaho and southwestern Montana (fig. 39). The granite gneiss is considered older pre-Cambrian (Archean) by Umpleby (1913, pp. 41–42) and Winchell (1914, p. 29). The metamorphosed sedimentary rocks consist of quartzite with interbedded mica schist, gneiss, and slate that Umpleby (1913, pp.

[3] Adams, J. W., and King, R. U., 1950, Pitchblende occurrence at the Sunshine mine, Shoshone County, Idaho: U. S. Geol. Survey Trace Elements Memo. Rept. 29.

[4] Klepper, M. R., 1950, Forty-Niner, King Solomon, Ridge, and West End claims near Clancey, Jefferson County, Mont.: U. S. Geol. Survey Trace Elements Memo. Rept. 31; and, 1950, Comstock claims near Basin, Jefferson County, Mont.: U. S. Geol. Survey Trace Elements Memo. Rept. 127.

[5] Thurlow, E. E., and Reyner, M. L., 1950, Free Enterprise property, Jefferson County, Mont.: U. S. Atomic Energy Comm. Raw Materials Operations, New York, N. Y.

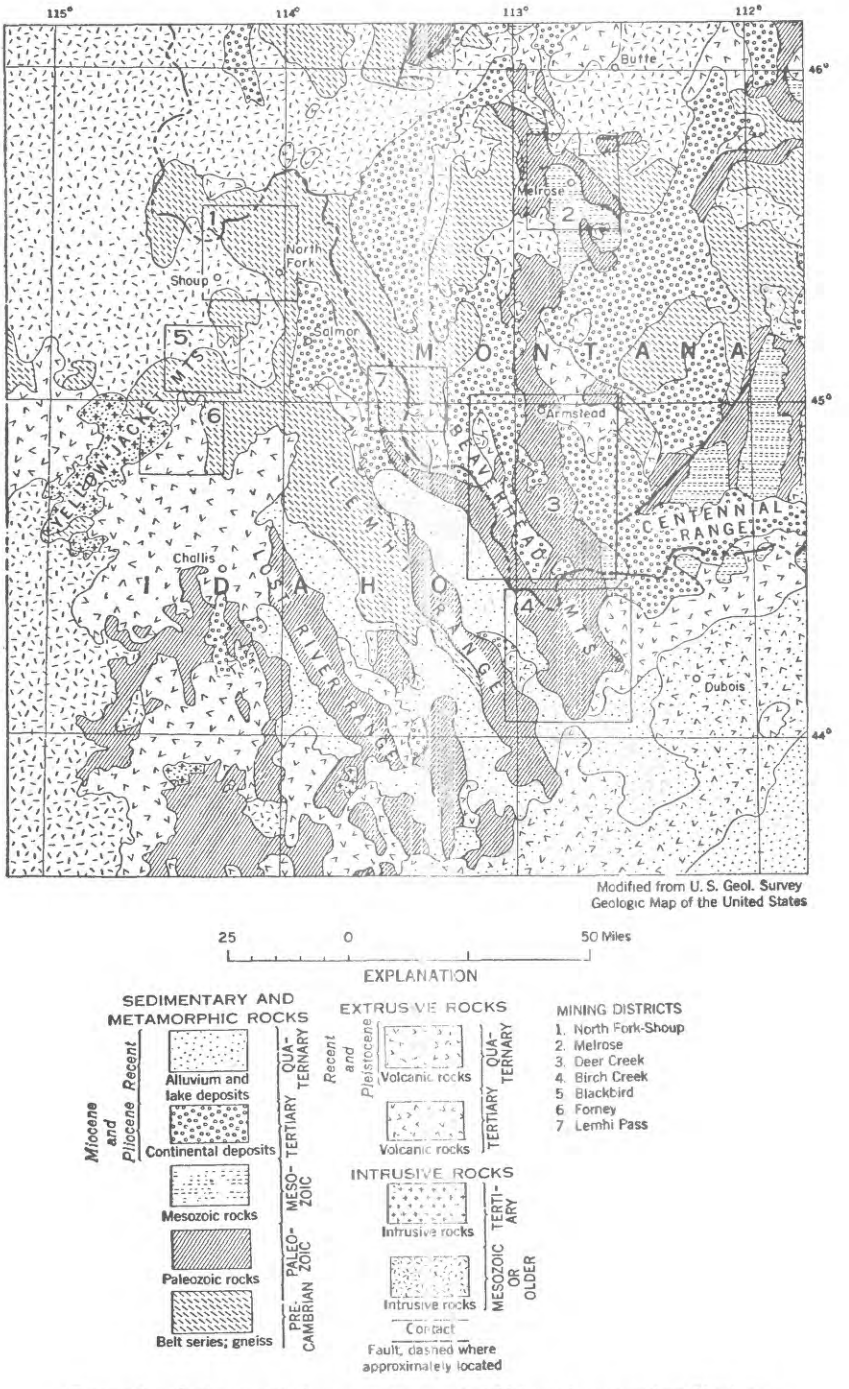


FIGURE 39.—Geologic and index maps of east-central Idaho and southwestern Montana

30–32) and Wilson (1937, pp. 197–203) assign to the Belt series and younger pre-Cambrian (Algonkian) rocks.

A thick sequence of Paleozoic rocks, lying unconformably on the pre-Cambrian rocks, on the flanks and south ends of the Lemhi Range and the Beaverhead Mountains, Idaho, has been described by Umpleby (1917, pp. 23–32). Sloss (1950, pp. 423–451), and Klepper (1951, pp. 59–66) have described the sequence at various places in southwestern Montana. The Paleozoic rocks include quartzite of Cambrian age; sandstone, limestone, and dolomite of Ordovician age; limestone, dolomite, and shale of Devonian age; limestone and sandstone of Carboniferous age; cherty quartzite, shale, and phosphate rock of Permian age. These rocks have been described by Sahinen (1939, pp. 14–17), by Winchell (1914, pp. 26–28), by Scott (1939, pp. 1011–1032), by Condit (1918, pp. 111–113), and by Sloss and Hamblin (1942, pp. 305–335).

Mesozoic rocks are absent except in the southern part of the Beaverhead Mountains where red conglomerate and thin limestone beds of Triassic age have been mapped by Kirkham (1927, p. 21); in the Centennial Range where redbeds of Triassic age, sandstone and shale of Jurassic age, and sandstone and shale of Cretaceous age have been described by Mansfield (1920, pp. 123–125 and 128–132); and in a few localities in southwestern Montana where Jurassic sandstone and Cretaceous sandstone and shale have been described.

A thick sequence of thin-bedded shale and sandstone of Miocene age, extending southeastward more than 90 miles from a point north of Salmon, Idaho, has been described by Umpleby (1913, pp. 35–40). Deposits of sand, clay, gravel, conglomerate, and volcanic ash of Oligocene and Pliocene age occupy many of the larger valleys, according to Winchell (1914, pp. 24–25).

IGNEOUS ROCKS

INTRUSIVE ROCKS

Late Mesozoic rocks of the Idaho batholith underlie large areas in northern Lemhi County, Idaho; rocks similar to the Boulder batholith have intruded as stocks in southwestern Montana. These rocks are predominantly granite, but are partly quartz monzonite and quartz diorite. More calcic rocks, says Anderson (1942, pp. 1099–1126), occur locally in the marginal facies of the Idaho batholith. Vhay noted some feldspar introduced into the country rock near the margins of the granite in the Blackbird district, Idaho.

Dikes are abundant in the western part of Lemhi County and in the Lemhi Range, Idaho; they are less common in southwestern Montana. The dikes, composed of granite, rhyolite, dacite, syenite, trachyte, diorite, quartz diorite, lamprophyre, aplite, pegmatite,

gabbro, basalt, and monzonite, range from less than a foot to 1,000 feet in thickness. Some of the dikes are pre-Cambrian in age, whereas others belong to the late Cretaceous or Tertiary.

EXTRUSIVE ROCKS

Tertiary lava is exposed in a large area near Challis, Idaho, and in scattered localities in east-central Idaho and southwestern Montana. The Challis volcanics comprise rhyolite, andesite, latite, basalt, trachyte, and dacite. Pleistocene and Recent basalt flows of the Snake River plain have been mapped by Stearns (Stearns, Crandall, and Steward, 1938, pp. 56–105) in the southeastern part of the area and in southwestern Montana.

STRUCTURE

The rocks of east-central Idaho and southwestern Montana were folded in at least three periods of deformation. The earliest known deformation is pre-Belt in age. During this orogeny the schists and gneisses of the older pre-Cambrian were folded, contorted, and uplifted; but before the deposition of the sediments of the Belt series they were beveled by erosion.

In the Laramide orogeny the rocks again were intensely folded and faulted. Anderson (1947, p. 1,162) believed the Idaho batholith acted as a strong rigid mass and transmitted the Laramide orogenic stresses into the bordering sedimentary rocks. The stresses compressed the Paleozoic sedimentary rocks into northwest-, north-, or northeast-trending folds, and large thrust faults were formed. Many normal faults subsequently resulted from tensional stresses.

Gentle post-Miocene tilting has been observed by Umpleby (1917, pp. 39–40) in places within the area, but it is not considered to be of great significance.

URANIUM AND THORIUM DEPOSITS

Uranium deposits have been found in the North Fork-Shoup district in Idaho, and in the Deer Creek and Melrose districts in Montana. They are in pre-Cambrian quartzites and phyllites of the Belt series, Paleozoic limestones, shales, and quartzites, and Upper Cretaceous porphyroblastic gneiss. The deposits of the North Fork-Shoup and Melrose districts are in the vicinity of granitic rocks of the Idaho and Boulder batholiths, respectively, and those of the Deer Creek district are near post-Paleozoic granite that possibly is related to the Boulder batholith.

The ore deposits examined for uranium in the area comprise veins, fissure fillings, and replacement bodies along shear zones and along folds in the host rock; dikes; and contact metamorphic deposits. Uranium occurs in significant quantity in roughly one-half the veins,

but was not found in the dikes or contact-metamorphic zones examined.

The veins that contain metallic ore minerals may be subdivided on the basis of their principal metal content, as gold, lead, copper, cobalt-copper, and lead-silver deposits. Uranium occurs in each of these types and is most abundant in the gold, lead, and copper veins. The cobalt-copper and lead-silver veins examined do not appear to contain significant amounts of uranium. Some quartz-hematite veins, barren of metallic ore minerals, also contain uranium.

Thorium deposits occur in the Lemhi Pass district, Idaho and Montana, and in the Deer Creek district, Montana. The deposits at Lemhi Pass are in sandstones, argillites, and quartzites of the Belt series, and the deposits at Deer Creek are in pre-Cambrian hornblende gneiss.

Thorium is most abundant in copper and quartz-hematite veins. Some granite and diorite-pegmatite dikes contain thorium in small amounts, but are not considered significant sources of thorium.

MINERALOGY

URANIUM MINERALS

The principal uranium minerals identified in the deposits are torbernite and autunite (?); other unidentified uranium minerals also have been found. Metallic minerals found in the uraniferous veins are pyrite, galena, copper, gold, hydrous iron oxides, malachite, azurite, and manganese minerals; nonmetallic minerals include quartz, chlorite, and clay minerals.

The uranium minerals commonly occur in small lenses and stringers in fracture zones. They form coatings on fractures outward from the vein fillings or on small crosscutting fractures in the vein. Rarely the uranium deposits are as much as 150 feet long and 5 feet wide.

TORBERNITE AND AUTUNITE

Torbernite ($Cu(UO_2)_2(PO_4)_2.8–12H_2O$) occurs in the lead-bearing vein at the Garm-Lamoreaux mine, North Fork-Shoup district, Idaho, as small apple-green crystals, 0.1 mm across, associated with galena, pyrite, hydrous iron oxides, quartz, chlorite, and a yellow fluorescent mineral which may be autunite ($Ca(UO_2)_2(PO_4)_2.10–12H_2O$). Pale green torbernite crystals, 0.1 mm across, are associated with malachite and hydrous iron oxides as fracture coatings in the gold-bearing quartz vein at the Moon prospect, North Fork-Shoup district, Idaho.

OTHER URANIUM MINERALS

Unidentified uranium minerals occur with hydrous iron oxides in the copper-bearing quartz vein at the Iola prospect, Deer Creek district, Montana. The native copper, malachite, and azurite occur in lenses

within the quartz vein, and apparently are not associated with the uranium minerals. Unidentified uranium minerals also occur with hydrous iron oxides, hematite, clay minerals, and manganese oxides in the quartz-hematite veins in the Melrose district, Montana.

THORIUM MINERALS

Thorite, hydrothorite (?), monazite, and allanite occur in the thorium-bearing veins and dikes of Idaho and Montana, but only thorite and hydrothorite (?) were found in significant amounts. Thorite is the principal radioactive mineral in the quartz-hematite veins, and probably occurs in the radioactive copper veins of the Lemhi Pass district. In the quartz-hematite veins the thorite occurs as disseminated crystals associated with quartz, hematite, hydrous iron oxides, and barite. In the copper veins the thorium minerals are associated with barite, chalcopyrite, malachite, azurite, quartz, pyrite, and hydrous iron oxides.

THORITE

Thorite ($ThSiO_4$) has been identified in samples from two quartz-hematite veins in the Lemhi Pass district by Kiyoko Onoda of the U. S. Geological Survey Trace Elements Section Washington Laboratory. The mineral is largely isotropic (metamict) and has variable indices of refraction that in general range from 1.74 to 1.76. These indices are lower than the average indices (1.82 to 1.86) recorded by George (1951, pp. 129–132) for uraniferous thorite from gold placers of central California and a little lower than the indices of refraction, 1.78 and 1.79, given by Hutton (1950, p. 681) on phosphorus-bearing thorite chemically similar to auerlite in which some of the $(SiO_4)^{-4}$ has been replaced by $(PO_4)^{-3}$. The crystals are partly altered to hematite and goethite along distinct basal cleavage planes.

Four separate thorite samples were prepared and analyzed spectrographically by Onoda. The thorite was handpicked under the binocular microscope from the nonmagnetic part of the heavy minerals obtained by methylene iodide separation. The results of spectrographic analysis of these thorite-rich fractions are shown below:

Sample no.	Description	Major constituents	Minor constituents	Trace constituents
1	Thorite and some quartz, Trapper no. 1 claim.	Th, P, Si	Fe	Pb
2	Barite and thorite, Brown Bear claim	Ba, Th, Si	Fe	Cu
3	Barite, thorite, and hematite, Trapper no. 1 claim.	Th, Fe, Si	Ba, Mn	Cu, Mg
4	Barite and thorite, Trapper no. 1 claim	Ba, Si	Th	Fe, Cu

Chemical analyses of thorite and similar minerals described by George,[6] by Dana (1920, p. 489), and by Hutton (1950, p. 681) are shown in table 1. The analyzed 4 samples of thorite from Lemhi Pass contain no detectable rare earth elements or uranium, thereby distinguishing it from most of the thorite in table 1.

TABLE 1.—*Chemical analyses of thorite and similar minerals* [1]

	1	2	3	4	5	6	7	8	9	10
CaO	2.58	1.59	1.99	1.28	0.41	1.65	4.00	0.57	N. D.	0.49
MgO	.36	Tr.	.28	.15	------	.60	.95	.21	------	.29
FeO	------	------	------	.20	------	Nil.	------	Nil.	------	------
PbO	.80	.88	1.67	7.90	2.16	1.25	------	17.26	.09	------
K_2O	.14	.14	------	Nil.	------	Nil.	.11	.09	------	------
Na_2O	.10	.33	------	Nil.	------	Nil.	2.48	.04	------	------
Ce_2O_3	------	------	1.39	.10	------	.24	------	.19	} .52	------
$(Ce, La)_2O_3$	------	------	------	------	} 6.69	------	8.55	------		------
$(Y, Er)_2O_3$	------	------	------	.25		.73	5.95	.49		------
UO_2	------	------	------	35.60	------	Nil.	------	Nil.	} 8.43	------
UO_3	1.58	1.13	9.78	------	22.43	2.98	------	27.09		------
ThO_2	57.91	71.65	50.06	24.72	41.44	57.79	35.96	31.24	69.36	70.02
Al_2O_3	.06	.17	------	Tr.	.96	.88	1.77	.15	1.25	1.10
Fe_2O_3	3.40	.31	7.60	Nil.	.85	Nil.	4.25	.20	71	1.38
SiO_2	18.98	17.52	17.04	16.19	13.08	15 77	16.20	12.72	15.96	7.65
H_2O	9.50	6.14	9.46	12.92	9.11	15.18	9.15	7.66	.82	11.21
P_2O_5	------	------	------	------	------	------	------	------	------	7.46
Remainder	4.10	.28	.86	.74	1.19	2.83	10.84	1.08	------	------
	99.51	100.14	100.13	100.05	98.32	99.90	100.21	99.56	97.23	99.70
Sp gr	4.8	5.19	4.38	4.45	4.43–4.54	------	4.39	4.68	6.36	------

[1] Table from George (1949, pp. 93–94). Analysis of auerlite from Hutton (1950, p. 681).

1. Thorite. Brevik, Norway. Remainder is Mn_2O_3 2.39; SnO_2 0.01; insol. 1.70; uranium given is U_3O_8.
2. Orangite. Brevik, Norway. Remainder is Mn_2O_3 0.28; uranium given is U_3O_8.
3. Uranothorite. Arendal, Norway. Remainder is P_2O_5 0.86.
4. Mackintoshite. Wodgina, western Australia. Remainder is MnO 0.07; Ta_2O_5 0.67; CO_2 trace; H_2O given as $-H_2O$ 0.88, $+H_2O$ 12.04.
5. Thorogummite. Llano County, Tex. Remainder is P_2O_5 1.19; H_2O given as $-H_2O$ 1.23, $+H_2O$ 7.88. Atomic weight of rare earths 135.
6. Hydrothorite. Wodgina, western Australia. CO_2 −1.50; P_2O_5 1.33; H_2O given as $-H_2O$ 9.12, $+H_2O$ 6.06.
7. Eucrasite. Barkevik, Langesund Fiord, Norway. Remainder is TiO_2 1.27; SnO_2 (?) 1.15; ZrO_2 0.60; MnO_2 2.34; CeO_2 5.48.
8. Pilbarite. Wodgina, western Australia. Remainder is P_2O_5; H_2O given as $-H_2O$ 3.50, $+H_2O$ 4.16.
9. Thorite. Tuolumne River, La Grange, Calif.
10. Auerlite. Henderson County, N. C. Al_2O_3 includes a trace ThO_2; H_2O includes CO_2.

HYDROTHORITE (?)

Minor amounts of thorium in the quartz-hematite veins are believed to be in alteration products of thorite, possibly as the hydrate, hydrothorite ($ThSiO_4.4H_2O$), that occurs with the iron oxides in small crosscutting fractures within these viens.

MONAZITE

Three small monazite crystals were observed in the plagioclase-muscovite-quartz-perthite pegmatite wall zone of the Snowdrift pegmatite in the North Fork-Shoup district, Idaho. Monazite (essentially (Ce, La, Th) PO_4 with ThO_2 and SiO_2) is also the principal radioactive mineral found by Onoda in the heavy-mineral fraction of a sample from a diorite pegmatite dike on the Gray Goose no. 1

[6] George, D. R., 1949, Mineralogy of uranium and thorium bearing minerals: U. S. Atomic Energy Comm. Rept. RMO-563.

claim, Deer Creek district, Beaverhead County, Mont. A spectrographic analysis of monazite from the claim shows Th, Co, and P, as major constituents; La and Si as minor constituents, and Y, Ca, Mg, and Pb as trace constituents.

ALLANITE

Allanite ($(Ca, Ce, Th)_2 (Al, Fe, Mg)_3 Si_3O_{12} (OH)$) was found in the sample from the diorite pegmatite dikes, in which it is closely associated with biotite. A spectrographic analysis of the allanite shows Fe, Mg, and Si as major constitutents; Th, Ce, La, P, Ca, Al, and Mn as minor constitutents; and Y, Ti, and Pb as trace constituents.

GRADE AND RESERVES

The grade of the known uranium and thorium deposits in east-central Idaho and southwestern Montana is poorly known because the deposits have not been developed extensively. Sampling of available exposures, both on surface and underground, indicates that the uranium deposits range in grade from 0.02 to 0.1 percent uranium and that uranium reserves now known are small. The estimated grade of the thorium deposits is somewhat higher than the uranium deposits, ranging from 0.1 to 1.2 percent thoria (ThO_2). The inferred reserves are also greater than those of uranium. Additional exploration of the known thorium and uranium deposits and further prospecting in the adjoining areas may indicate much larger reserves.

MINE DESCRIPTIONS

NORTH FORK-SHOUP DISTRICT, IDAHO

Uranium occurs in at least three deposits in the North Fork-Shoup district. Vhay reported samples from the Garm-Lamoreaux mine to contain as much as 0.11 percent uranium, and a sample of mill concentrates from the Grunter mine to contain 0.043 percent uranium. The writers visited the Garm-Lamoreaux mine, and examined six additional properties for uranium and thorium. Significant amounts of uranium were found at one other deposit, the Moon prospect; a small amount of thorium is indicated at two properties, the Smith and the Snowdrift claims.

The geology and ore deposits in the North Fork-Shoup district have been described by Umpleby (1913, pp. 127–134 and 138–159). The pre-Cambrian Belt series of thin-bedded micaceous schists and quartzites is exposed in the eastern part of the district (fig. 40). These metasedimentary rocks strike generally N. 20° W. and dip from 40° to 70° NE. The Belt series rocks rest unconformably on the older pre-Cambrian granite gneiss exposed near Shoup in the southwestern part of the district.

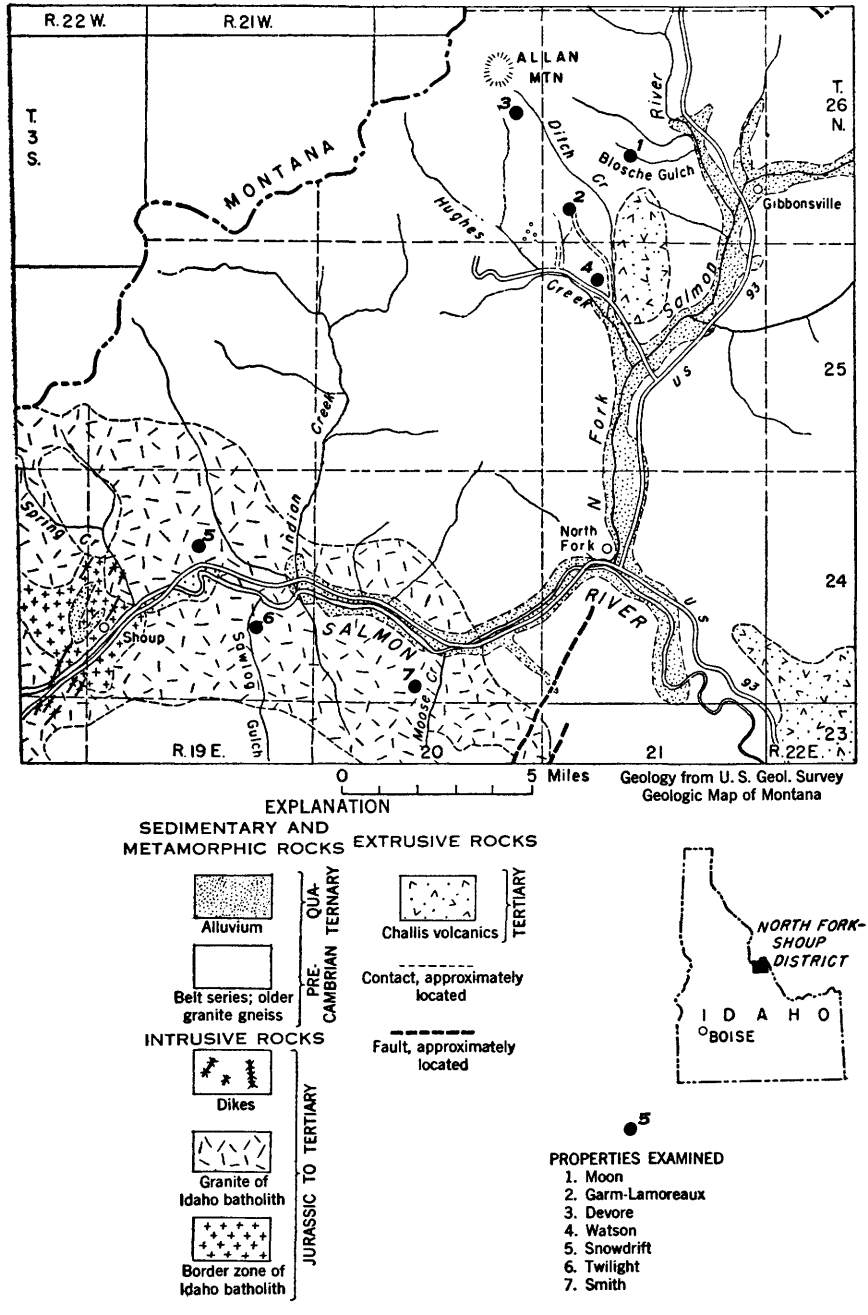


FIGURE 40.—Geologic and index maps of the North Fork-Shoup district, Idaho.

A large granite body, part of the Idaho batholith, extends southeastward from Shoup across the southwestern part of the district. Granite gneiss occurs along some of the contacts of the batholith. This gneiss has been intruded by large dikes of granite porphyry, diorite, basalt, and quartz prophyry. Tertiary andesitic and rhyolitic flows occur west of Gibbonsville and east of North Fork, and are believed to be younger than the dikes.

Ore deposits in the North Fork-Shoup district occur in the older pre-Cambrian granite gneiss, Belt series rocks, and in the granitic rocks of the Idaho batholith; they are especially abundant in the altered rocks near the margins of the batholith. Gold, the principal metal recovered in the district, has come mainly from shallow mines in small quartz-pyrite veins, some of which contain small amounts of galena, chalcopyrite, and sphalerite.

GARM-LAMOREAUX MINE

The Garm-Lamoreaux mine, in sec. 31, T. 26 N., R. 21 E., Boise meridian, is 11 miles north of North Fork, Idaho, on Allen Creek, a small tributary of Hughes Creek. The property is an unpatented claim held by the Garm-Lamoreaux estate, for which Ralph E. Yates, 631 South Fourth Street, Springfield, Ill., is the agent and G. I. Hurley, Salmon, Idaho, is the local manager. J. E. Goggins and Keith Evarts of Salmon were leasing the property during the summer of 1950.

The deposit was worked through three adits which were inaccessible at the time of the writers' visit. Adit 1 is about 55 and 150 feet above adit 2 and adit 3, respectively. A fourth adit is being driven from a point approximately 245 feet below adit 3.

Vhay [7] has described the geology of the Garm-Lamoreaux mine. The country rocks are quartzite, schist, and phyllite or argillite of the Belt series.

Uraniferous lead ore is reported to occur in lenses and thin stringers in a main fracture zone that strikes approximately N. 80° W. and dips 60 to 80° NE. where it is exposed in adit 2. The fracture zone is not recognizable on the surface, because of the soil cover. The zone has been cut by adit 1 and has been explored for about 80 feet by adit 2. The vein contains galena and gold in a gangue of quartz, pyrite, and goethite. Torbernite crystals, 0.1 mm across, occur in the ore, associated with a fluorescent yellow mineral which may be autunite.

The analyses of samples from the mine dumps indicate that radioactive material was removed from adits 2 and 3. A small amount of lead ore in the northeast corner of the dump below adit 3 contains the highest radioactivity.

[7] Op. cit., pp. 7-8.

Vhay [8] reported 0.11 percent uranium in selected vein material from this part of the dump. The results of the equivalent uranium [9] and uranium determinations are shown in table 2.

TABLE 2.—*Equivalent uranium and uranium analyses, in percent, Garm-Lamoreaux mine*

Sample no.	Location	Description	Equivalent uranium	Uranium
AFT-S5-50	Northeast part of adit 3, dump	Composite sample of vein material	0.013	0.009
AFT-S2-50	Near center of adit 2, dump	Grab sample of dump material containing limonite-stained quartz.	.007	.005
AFT-S3-50	do	do	.014	.010
AFT-S4-50	do	Grab sample of dump material	.003	.001
AFT-S6-50	North and south parts of adit 2, dump	Composite sample of dump material.	.003	.001
AFT-S7-50	Adit 1, dump	do	.004	.001

MOON CLAIM

The Moon claim is in sec. 21, T. 26 N., R. 21 E., Boise meridian, near Blosche Gulch, a small tributary of the North Fork of the Salmon River, 3 miles northwest of Gibbonsville, Lemhi County, Idaho. The property is held by the estate of Percy Anderson, Seattle, Wash.; C. W. Lyon of Salmon, Idaho, is the agent. C. C. Mathis and R. W. Dean of Gibbonsville had an option on the property in the summer of 1950. The deposit has been explored by a 700-foot adit and two open cuts.

The Moon claim is on a gold-quartz vein, which strikes N. 70° W. and dips steeply northeast, cutting quartzite and mica schist of the Belt series. The vein is more than 700 feet long and ranges from 2 to 4 feet wide. Small torbernite crystals, 0.1 mm across, occur with malachite and goethite on the surfaces of three fractures, 3 inches wide, which cut the gold-bearing quartz vein and extend outward from the vein into the country rock for less than 10 feet. Two of these fractures are exposed in the adit and the third in an open cut.

Torbernite-bearing quartz float is found about 3,000 feet N. 70° W. of the mine workings but the vein has not been discovered.

Geiger-Mueller counter readings from 5 to 7 times background (2.0 on the 0.2 scale) were recorded on the three torbernite-coated fractures. Radiometric readings slightly higher than background were recorded on the quartz vein. Two selected samples of torbernite-bearing rock from the dump contain 0.41 and 0.16 percent equivalent uranium and 0.45 and 0.14 percent uranium, respectively.

[8] Op. cit., p. 16.

[9] Equivalent uranium is based on radiometric measurement wherein it is assumed that all of the radioactivity of a sample arises from uranium and its disintegration products and that none of the radioactivity arises from the thorium series or from potassium; it is assumed, furthermore, that the uranium is in radioactive equilibrium with all of its disintegration products wherein each radioactive product in the series is disintegrating at exactly the same rate at which it is being formed.

Although the torbernite-coated fractures in the Moon mine are small and appear to be discontinuous, additional uranium deposits may be discovered by further exploratory work. The area northwest of the property should be examined thoroughly for vein exposures, and and an attempt should be made to discover the torbernite-bearing quartz vein by bulldozer trenching.

SMITH PROSPECT

The Smith prospect is in sec. 33, T. 24 N., R. 20 E., Boise meridian, about three-fourths of a mile south of the Salmon River on the north side of a western tributary of Moose Creek, in Lemhi County, Idaho. The property is owned by A. S. Smith, Box 106, North Fork, Idaho. No development work has been done on the claim.

The Smith prospect is on a contact-metamorphic zone between a Tertiary diorite dike and older pre-Cambrian dark-gray, porphyroblastic granite gneiss that is apparently a large inclusion or roof pendant in the Idaho batholith. The granite gneiss is composed principally of feldspar, quartz, and biotite. The diorite dike, 75 feet wide, is a medium-grained gray to green rock, made up of plagioclase, biotite, and hornblende.

The contact-metamorphic zone strikes N. 25° E. and dips nearly vertical. It is more than 400 feet long and has an average width of 12 feet. The zone is composed of altered gneiss containing small pyrite and chalcopyrite crystals and is cut by small quartz lenses and stringers. Pyrite crystals are disseminated in the diorite dike for about 1 foot from the contact.

Geiger-Mueller counter readings on the altered zone ranged from slightly above background (2.0 divisions on the 0.2 scale) in the south and central parts to 4 times background in the northern part of the contact zone. Readings on the porphyroblastic gneiss and diorite were normal or slightly higher than background. A grab sample of the most radioactive material at the north end of the zone contains 0.016 percent equivalent uranium and 0.003 percent uranium. Much of the radioactivity is probably from thorium.

SNOWDRIFT CLAIM

The Snowdrift claim is in sec. 16, T. 24 N., R. 19 E., Boise meridian, about half a mile north of the Salmon River on the east side of a small unnamed gulch, 3 miles east of Shoup, Lemhi County, Idaho. The claim is owned by G. E. Shoup of Salmon, Idaho, who dug the two pits, the largest of which is 15 feet long, for scrap mica.

The Snowdrift claim is on a pegmatite dike that cuts older pre-Cambrian porphyroblastic gneiss and is separated from the gneiss by aplite. The pegmatite strikes N. 75° W. and dips 70° NE. It is

5 to 10 feet thick, and is reported by the owner to be more than 3,000 feet long.

The pegmatite contains four distinct zones: a quartz-muscovite-plagioclase border zone, a plagioclase-muscovite-quartz-perthite wall zone, a perthite-plagioclase-muscovite-quartz intermediate zone, and a quartz core. The average grain size ranges from $\frac{1}{32}$ inch in the border zone to 4 inches in the core. Three monazite crystals, $\frac{3}{4}$ inch across, were found in the intermediate zone, which is 2 to 4½ feet thick in the upper open cut.

Abnormal Geiger-Mueller counter readings from 2 to 5 times background (2.5 divisions on the 0.2 scale) were recorded on gauge in a small fault cutting the pegmatite core in the lower open cut and on monazite crystals in the upper open cut. The small amount of abnormal radioactivity is probably from thorium.

TWILIGHT CLAIM

The Twilight claim, in sec. 26, T. 24 N., R. 19 E., Boise meridian, is on Sawlog Gulch, approximately three-fourths of a mile south of the Salmon River, and 10 miles west of North Fork, Lemhi County, Idaho. The property is owned and operated for gold by Magnus Bevan, North Fork, Idaho. The principal workings are a 150-foot adit, a 30-foot adit, and a small open cut.

The Twilight claim is on a gold-bearing, hydrothermally altered, porous, fine-grained, feldspar-quartz-sericite pegmatite. The pegmatite cuts a large, sheared, medium-grained, biotite-granite sill which may be an off-shoot of the Idaho batholith. The gold mineralization may be associated with a 1½-inch vein of white fluorite, exposed in the wall of the longer drift.

The maximum Geiger-Mueller counter reading at the Twilight claim was 1½ times background (4.0 divisions on the 0.2 scale). This slightly abnormal radioactivity is probably caused by the thorium in minor amounts of monazite in the pegmatite.

DEVORE CLAIM

The Devore claim is in sec. 13, T. 26 N., R. 20 E., Boise meridian on the southeast slope of Allan Mountain.

The property is owned and operated by E. F. Devore of North Fork, Idaho. Workings consist of a 48-foot inclined shaft, a 400-foot tunnel accessible for 250 feet, and several pits and trenches.

The Devore claim is on a quartz vein cutting closely jointed quartz-muscovite schist of the Belt series. Foliation of the schist strikes N. 44° E. and dips 50° NW.; the most prominent joints strike N. 57° W. and dip 60° NE. The quartz vein strikes N. 45° W., and dips 60° NE., and has an average width of 1½ feet; its length is unknown. Ore minerals include bornite, chalcopyrite, malachite, gold, and

native silver in a gangue of quartz and hydrous iron oxide. No abnormal radioactivity was observed in the mine workings, on the dump, or on the ore stockpile.

WATSON CLAIM

The Watson claim is in sec. 7, T. 25 N., R. 21 E., Boise meridian, on the hillside north of Hughes Creek, 9 miles north of North Fork, Idaho. The claim is owned by H. S. Watson of North Fork. Workings consist of two adits, approximately 200 and 350 feet long.

The Watson claim is on quartz veins and lenses in closely jointed and highly contorted, green to gray phyllite and black slate of the Belt series, in which the foliation strikes northwest and dips northeast. Many small faults are exposed in the underground workings. The ore deposits occur both as replacement bodies in the country rock and as fillings in high-angle faults. The quartz veins and lenses are less than a foot thick; the replacement bodies are a fraction of an inch to 2 feet thick. Ore minerals include bornite, chalcopyrite, gold, and malachite; gangue minerals are quartz, pyrite, and goethite. No abnormal radioactivity was found on the Watson claim.

BLACKBIRD DISTRICT, IDAHO

Radioactive rock is known at two mines in the Blackbird district. Anderson [10] mentioned that J. S. Vhay noted radioactive material in the Calera mine, and Anderson reported small amounts of uranium in the Haynes-Stellite mine. The new workings at these two mines and seven other properties not previously examined showed no significant radioactivity.

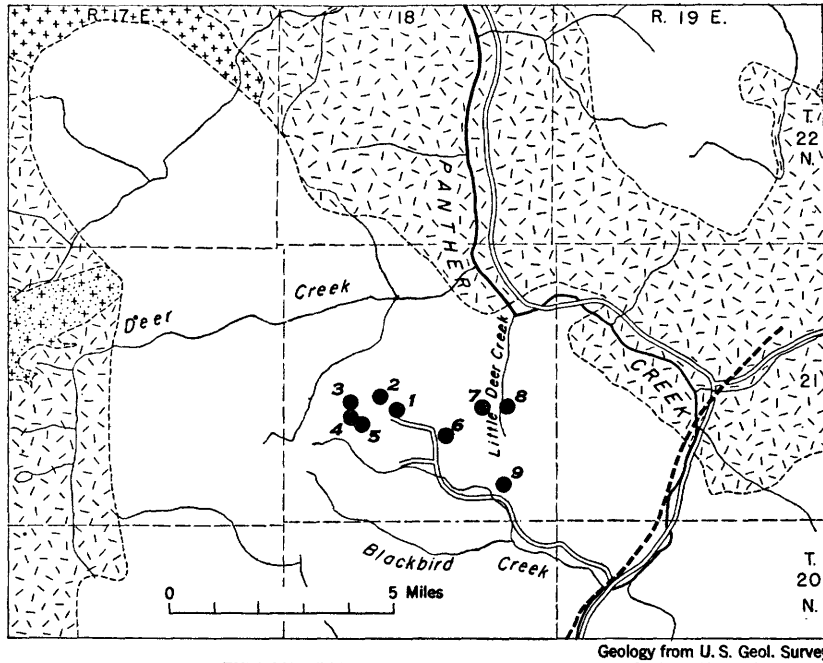
The Blackbird district, Lemhi County, Idaho, has been described by Umpleby (1913, pp. 71–72 and 159–165), Hess (1921, pp. 899–901), Anderson (1943), Reed (1947), Vhay, and Huttl (1950, pp. 89–91).

The rocks of the Blackbird district are pre-Cambrian quartzite, granulite, phyllite, and schist of the Belt series which have been intruded by Idaho batholithic granitic rocks (fig. 41). Vhay has divided these metamorphosed sedimentary rocks into three north-trending segments, the Blackbird, Lookout, and Haynes-Stellite structural blocks, separated by faults.

The Blackbird, the central block, is composed of highly schistose rocks which are bent into north-plunging folds and are cut by faults, shear zones, and basic dikes. The northern part is near granitic rocks of the Idaho batholith, and is characterized by the presence of garnet or chloritoid. Quartz-biotite rocks predominate in the southern part of the block.

The Haynes-Stellite segment, east of the Blackbird block, consists of nonschistose quartzite intercalated with some phyllite. These

[10] See p. 157; footnote 2 (p. 4).



Geology from U. S. Geol. Survey Geologic Map of Idaho

EXPLANATION

SEDIMENTARY AND METAMORPHIC ROCKS

- Alluvium
- Belt series; older granite gneiss

PRE-CAMBRIAN QUATERNARY

INTRUSIVE ROCKS

- Dikes and other small intrusive bodies
- Granite of Idaho batholith
- Border zone of Idaho batholith

JURASSIC(?) TO TERTIARY

- Contact, approximately located
- Fault, approximately located

PROPERTIES EXAMINED

1. Calera
2. Adit east of Cobalt triangulation station
3. Sunshine
4. Katherine
5. Ella
6. Hawkeye
7. Dusty
8. Copper Queen
9. Haynes-Stellite

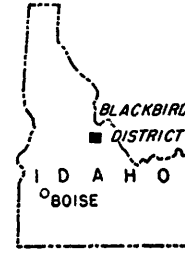


FIGURE 41.—Geologic and index maps of the Blackbird district, Idaho.

rocks are in relatively open north-plunging folds and are cut by faults and breccia zones.

West of the Blackbird segment is the Lookout block, which is composed of relatively nonschistose rocks except at the north end. The rocks are mainly quartzites and quartz-biotite granulites; schistose garnetiferous rocks occur at the north end near the granite The structure is more variable than in the other two blocks, and some south-plunging folds are present.

Igneous rocks of the Blackbird district include granite of the Idaho batholith at the north end and many thin dikes and small bodies of metamorphosed gabbro and unmetamorphosed quartz-feldspar porphyry, soda granite, and quartz monzonite.

Most of the ore deposits are in the Blackbird structural block; a few occur in the Haynes-Stellite and Lookout blocks. The mineral deposits have been formed mainly by replacement along shear zones and in the crests of north-plunging folds.

Ore minerals include cobaltite, chalcopyrite, safflorite, and minor chalcocite, covellite, and gold. The gangue minerals are pyrite, pyrrhotite, arsenopyrite, quartz, biotite, tourmaline, chlorite, muscovite, calcite, ankerite or siderite, vivianite, apatite, and ludlamite. Hematite, goethite, cobaltite, chalcanthite, erythrite, native copper, cuprite, malachite, jarosite, nontronite, and possibly heterogenite and pitticite occur in the zone of oxidation.

CALERA MINE

The Calera mine is in sec. 21, T. 21 N., R. 18 E., Boise meridian, on the hillside north of Blackbird Creek. The mine is owned and operated by the Calera Division of the Howe Sound Mining Company. It has been developed on five main levels: the 6,850-foot, 7,100-foot, 7,200-foot, 7,300-foot and 7,400-foot levels, which explore two broad shear zones for more than 1,700 feet.

Mineral deposits occur in the Blackbird structural block, mainly in north-northeast- and northwest-trending shear zones and crests of north-plunging folds. Ore minerals include cobaltite, chalcopyrite, and safflorite in a gangue of quartz, pyrite, biotite, and ankerite or siderite.

Radiometric examination of workings on the 7,100-foot, 7,200-foot, and 7,300-foot levels, opened after the examination in 1950 by Anderson, indicated no significant radioactivity.

ADIT 390 FEET EAST OF COBALT TRIANGULATION STATION

The adit 390 feet east of the Cobalt triangulation station is about 2,000 feet northeast of the Calera adit, in sec. 21, T. 21 N., R. 18 E., Boise meridian. The property is owned by the Calera Division of the

Howe Sound Mining Company. Workings consist of a 120-foot adit, now caved, and bulldozer trenches.

The adit is on a fault contact between garnet schist and biotite-quartz schist in the Blackbird structural block. Chalcopyrite, malachite, and cuprite in quartz gangue were found on the dump. No abnormal radioactivity was found on the dump, sides of the caved adit, or bulldozer cuts.

SUNSHINE PROSPECT

The Sunshine prospect is about 4,500 feet northwest of the Calera mine, in sec. 20, T. 21 N., R. 18 E., Boise meridian. An old mine road connects the prospect with the main Calera mine road. The prospect is owned in partnership by F. S. Stevenson of Forney, Idaho, and the Standard Oil Company of California. The deposit has been explored by a bulldozer trench and a 25-foot vertical shaft with a short drift extending northward at the bottom.

The Sunshine prospect is in biotite-cordierite-garnet schist in the Lookout structural block. The ore is in a quartz lens and in north-plunging folds in the schistose country rock. Cobaltite, chalcopyrite, and erythrite occur in the quartz gangue.

No abnormal radioactivity was found on the Sunshine prospect.

KATHERINE PROSPECT

The Katherine prospect, in sec. 20, T. 21 N., R. 18 E., Boise meridian, is about half a mile northwest of the Calera mine, and is owned by the Calera Division of the Howe Sound Mining Company. The vein was explored by a shaft and an adit, both of which are caved. The country rock is quartzite and quartz-muscovite-biotite schist of the Lookout structural block. Some limonite-stained quartz containing ankerite or siderite was seen on the dumps. No abnormally radioactive material was found at the Katherine prospect.

ELLA PROSPECT

The Ella prospect is in sec. 20, T. 21 N., R. 18 E., Boise meridian, about 2,000 feet northwest of the Calera mine. The property is owned by the Calera Division of the Howe Sound Mining Company. Workings consist of a caved shaft and a large bulldozer trench. The country rock is quartzite and quartz-muscovite schist of the Lookout structural block. Pieces of quartz, coated with limonite and a small amount of malachite, were found on the dump. No abnormal radioactivity was indicated at the Ella prospect.

DUSTY PROSPECT

The Dusty prospect is in sec. 23, T. 21 N., R. 18 E., Boise meridian, about 7,000 feet northeast of the Calera mine. The prospect is owned by a Mr. Palo of Forney, Idaho. Mine workings consist of two caved adits. The country rock is muscovite-biotite schist of the Blackbird structural block. The ore minerals, cobaltite and malachite, are in the crests of folds in the schist, in gangue of quartz and tourmaline. No abnormal Geiger-Mueller counter readings were recorded at the Dusty prospect.

HAWKEYE PROSPECT

The Hawkeye prospect is in sec. 27, T. 21 N., R. 18 E., Boise meridian, about 1 mile southeast of the Calera mine. The property is owned by the Calera Division of the Howe Sound Mining Company. The ore bodies have been explored by two adits, about 75 feet apart vertically. The upper 250-foot adit is caved about 30 feet from the portal, and the lower adit is caved at the portal. The adits are along replacement bodies and narrow stringers, in a shear zone and along the planes of schistosity, in quartz-biotite schist of the Blackbird structural block. Cobaltite, pyrite, and erythrite were noted on the dump. No abnormal radioactivity was found at the Hawkeye prospect.

COPPER QUEEN PROSPECT

The Copper Queen prospect is in sec. 23, T. 21 N., R. 18 E., Boise meridian, at the head of Little Deer Creek, and may be reached by road from the Calera mine. The property is owned by F. W. Stevenson, Forney, Idaho. Workings consist of a lower 270-foot adit, now caved, and an upper 160-foot adit.

The upper adit is in schistose rocks of the Blackbird structural block, and the lower adit is in quartzite, possibly of the Haynes-Stellite structural block. Oxidized copper minerals occur with clay formed by hydrothermal alteration in the schistose beds in the upper adit. Small amounts of quartz and probably pyrite have been introduced along minor fractures in the hydrothermally altered quartzite exposed in the lower adit. No significant radioactivity is indicated in the upper Copper Queen adit or dumps.

HAYNES-STELLITE MINE

The Haynes-Stellite mine is in sec. 35, T. 21 N., R. 18 E., Boise meridian, on the hillside north of Blackbird Creek. The mine is owned by F. W. Stevenson, Forney, Idaho. Mine workings consist of three main adits, a fourth adit 1,650 feet N. 85° W. from the portal of the lowest of the three, and a fifth adit about 500 feet southwest of the lowest.

The mine is on a breccia zone in quartzite, biotite-quartzite, and phyllite of the Haynes-Stellite structural block. The breccia in the three main adits contains fine-grained cobaltite in silicified and tourmalinized quartzite; the other two adits are on silicified faults with minor limonite.

Anderson [11] examined the three main Haynes-Stellite workings and found low-grade radioactive rock ranging from 0.003 to 0.018 percent equivalent uranium. The present examination was restricted to the new adit southwest of the main Haynes-Stellite adits. No conspicuous radioactivity was found in this adit.

FORNEY DISTRICT, IDAHO

The Forney district, as defined in this paper, is the area extending from Forney southwest 12 miles to Meyers Cove. Umpleby (1913, pp. 172–177) has described the geology and ore deposits of the Meyers Cove area. Uranium and thorium minerals have not been reported from the Forney district, and no abnormal radioactivity was found at the ore deposit examined. Metamorphosed sedimentary rocks of the Belt series are exposed in the northeastern and eastern part of the Forney district, as shown in figure 42. Most of the rocks of the district are igneous, and include Permian and Triassic volcanic rocks in the southwestern part, granite and other rocks in small stocks related to the Idaho batholith in the western part, and the Tertiary Challis volcanics in the southeastern part of the district.

The ore deposits of the district occur principally in an area extending about 10 miles eastward from Meyers Cove. Most of the deposits are veins which strike N. 35–40° E. and dip steeply northwest, cutting Challis volcanics. The mines, all of which are less than 300 feet deep, have been operated for gold and silver.

SINGISER MINE

The Singiser (Monument) mine is in sec. 25, T. 18 N., R. 17 E., Boise meridian, on the north slope of Arrastre Creek Valley, about 1½ miles above the junction of Arrastre Creek with Silver Creek. The property is about 10 miles southwest of Forney, Idaho, and is owned by H. L. Loop of Spokane, Wash. Umpleby (1913, p. 176) notes that the vein has been explored by a 200-foot inclined shaft with drifts on the 40-foot, 100-foot, and 200-foot levels; underground workings total 3,000 feet. All workings except the Hoist and 40-foot levels are flooded.

The Singiser mine is on a quartz vein, 3 to 8 feet wide, in the hangingwall of a shear zone that strikes N. 22–40° E. and dips 62–65°

[11] See p. 157; footnote 2 (pp. 5–6).

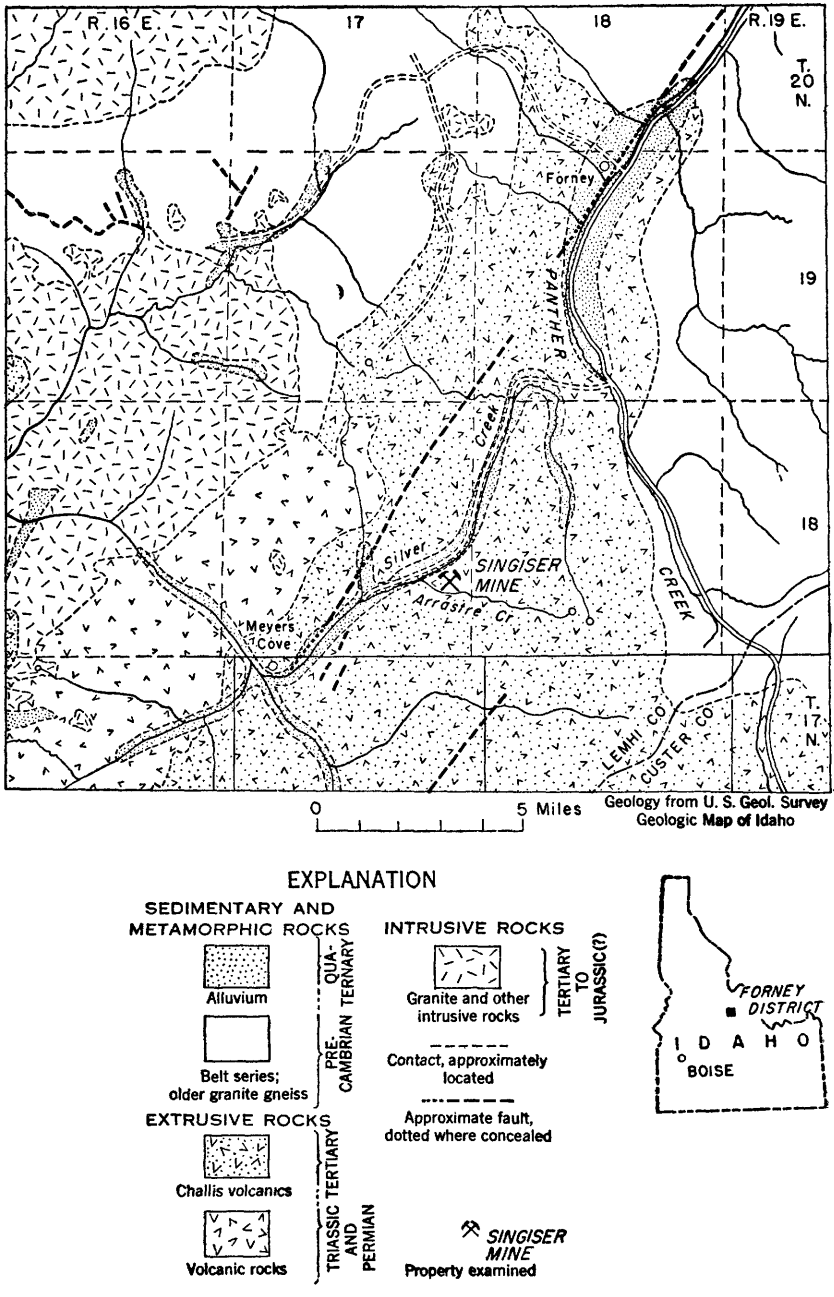


FIGURE 42.—Geologic and index maps of the Forney district, Idaho.

NW., cutting rhyolite flows of the Challis volcanics. The rhyolite is a light gray, porphyritic rock, containing small quartz and orthoclase phenocrysts in a fine-grained groundmass. Flow banding is prominent in much of the rhyolite. In addition to the main vein there are many ribbon quartz veins in the rhyolite.

The quartz vein contains small crystals of pyrite and gold selenides. The vein has been brecciated locally by intense postmineral faults, and the resulting breccias consist of angular fragments of quartz in a matrix of hydrothermally altered, limonite-stained gouge containing a trace of azurite. No abnormal radioactivity was found on the surface of the vein, dumps, or underground workings.

BIRCH CREEK DISTRICT, IDAHO

The Birch Creek district is on the southeastern end of the Beaverhead Mountains in Clark County, Idaho, about 65 miles by road northwest of Idaho Falls and 36 miles by road west of Dubois, the nearest railroad point. Two properties in the district were examined for uranium after a sample from the Scott mine, submitted by the owners, was determined by the U. S. Geological Survey Trace Elements Section Denver Laboratory to contain a small amount of uranium. Samples from the two deposits examined, the Scott mine and the Iron Blowout prospect, contain a maximum of 0.004 percent uranium. The uranium content of both of these deposits appears to be very small.

The geology and ore deposits of the Birch Creek district have been described by Umpleby (1917, pp. 118–119), Shenon (1928), and Anderson and Wagner (1944). Paleozoic limestone, dolomite, shale, and sandstone beds are the most abundant rock formations of the district, as shown in figure 43. These sedimentary rocks strike northwest and dip 20° to 30° NE. They are cut by narrow basalt dikes that have been correlated with flows of the Snake River plain. The ore deposits of the Birch Creek district occur in fracture zones and replacement bodies in the sedimentary rocks. The principal metals recovered have been lead and silver.

SCOTT MINE

The Scott mine, the principal mine in the Birch Creek district, is in sec. 31, T. 9 N., R. 31 E., Boise meridian, in Clark County, Idaho. The property consists of 10 unpatented claims owned by the Birch Creek Mining Company, Idaho Falls, Idaho. The Scott mine has been developed by two shafts and more than 7,600 feet of drifts and crosscuts. The drift levels are at depths of 100, 150, 166, and 200 feet.

The country rock consists of Paleozoic limestone, shale, quartzite, and sandstone. Tertiary volcanic tuff crops out west of the property,

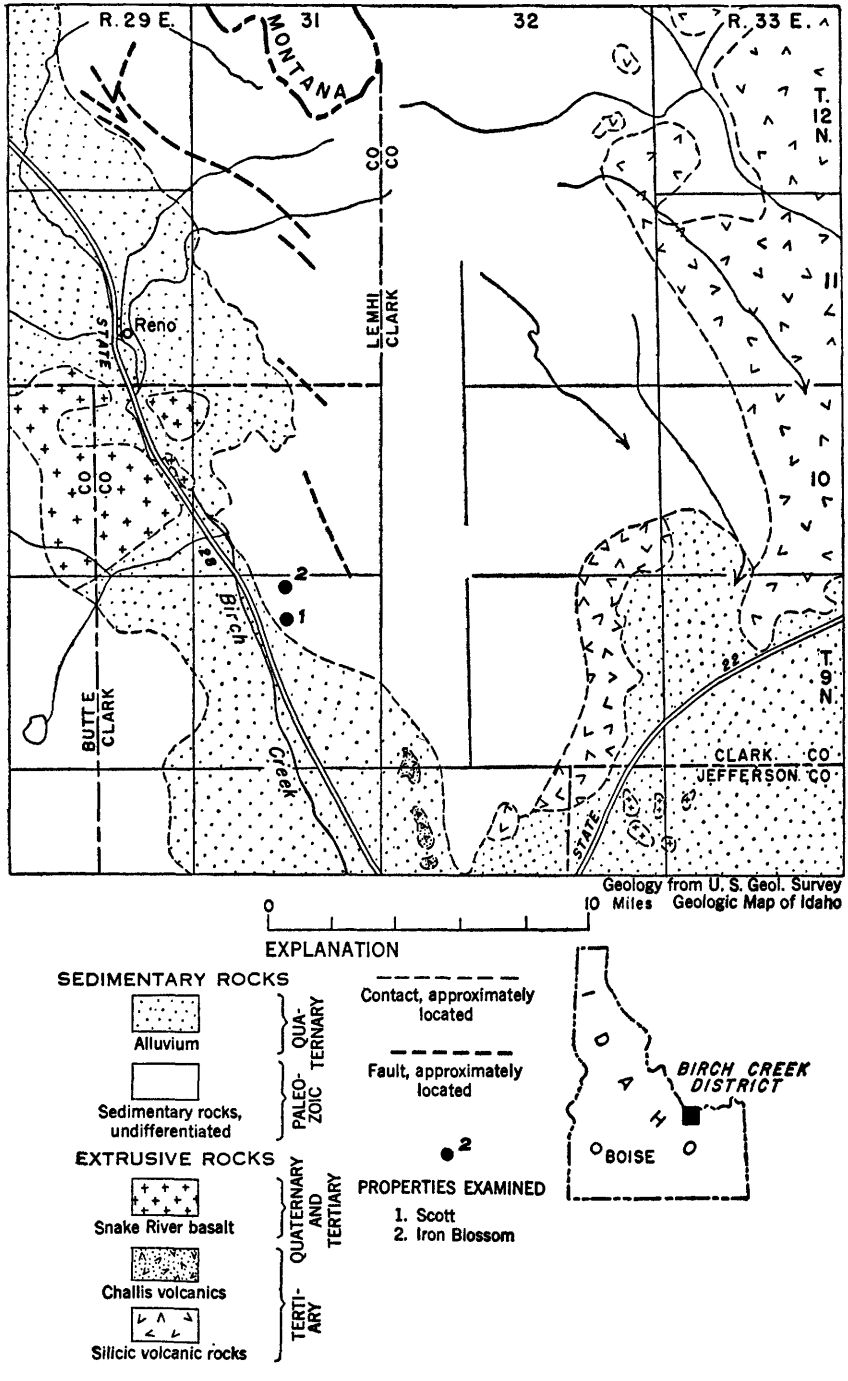


FIGURE 43.—Geologic and index maps of the Birch Creek district, Montana.

and Tertiary basalt caps the ridge west of the mine. A basalt dike cuts the vein near one of the shafts. Intense faulting has broken and tilted the rocks. Lead and silver minerals occur in shear zones and replacement bodies in impure limestone; lead ore is found mostly in fissures that strike N. 20°–40° W. and dip steeply northeast. Veins also occur along bedding plane surfaces, but these contain mainly hematite and limonite and minor galena. The steeply dipping veins have been repeatedly offset to the east by bedding-plane faults.

The principal ore minerals are galena, anglesite, and cerussite; wulfenite, plumbojarosite, smithsonite, and pyromorphite have also been described. Gangue minerals include cryptocrystalline quartz, goethite, hematite, manganese oxides, siderite, barite, and gypsum.

Maximum Geiger-Mueller counter readings of approximately 3 times background (2.5 division on 0.2 scale) were recorded on hematite veins on the 150-foot and 200-foot levels, and 2 times background in yellow gossan at the portal of a small adit near the old shaft. None of the lead veins is radioactive. Table 3 shows the uranium content of samples taken from the radioactive veins. The highest uranium content of the samples analyzed is 0.004 percent, and this is considered the maximum grade in the mine.

TABLE 3.—*Equivalent uranium and uranium, in percent, Scott mine*

Sample no.	Location	Description	Equivalent uranium	Uranium
AFT-S1-50	150-foot level, drift on west edge of backfilled crosscut.	Grab sample of hematite vein	0.011	0.002
AFT-S8-50	do	do	.001	.001
AFT-S9-50	150-foot level, on southwest wall on west side of winze.	Chip sample across hematite in bedding planes of limestone.	.005	.002
AFT-S10-50	150-level at head of inclined raise	Grab sample of hematite vein	.006	.004
AFT-S11A-50	200-foot level, near north end	do	.002	.000

IRON BLOWOUT PROSPECT

The Iron Blowout prospect is about 2 miles north of the Scott mine, and is reached from the mine by a poor road. The property is owned by the Birch Creek Mining Company, Idaho Falls, Idaho. A large discovery pit, 15 feet deep, has been dug on the property.

The Iron Blowout prospect is on two wide shear zones, composed of fault gouge and brown hydrous iron oxides, cutting Paleozoic limestone. These shear zones are about 12 feet apart and are converging toward the west. The northern zone is exposed in the north side of the pit where it strikes N. 83° E. and dips 85° NW., and is from 2 to 4 feet wide. The southern zone, exposed in the south side of the pit, strikes N. 72° W. and dips 80° NE., and is more than 5 feet wide. Samples from both shear zones contain 0.004 percent uranium as

shown in table 4. The uranium content is too low to indicate a commercial deposit.

TABLE 4.—*Equivalent uranium and uranium, in percent, Iron Blowout prospect*

Sample no.	Location	Description	Equivalent uranium	Uranium
AFT-S11N-50	North side of pit	Chip sample across northern shear zone.	0.002	0.004
AFT-S11S-50	South side of pit	Chip sample across southern shear zone.	.005	.004

MELROSE DISTRICT, MONTANA

The Melrose district, as defined in this paper, is an area of about 20 square miles immediately east of Melrose, Mont., in Silver Bow and Madison Counties. Three uraniferous deposits were examined in the district, shown on index map (fig. 44). These deposits contain from 0.015 to 0.035 percent uranium that is in an unidentified mineral associated with iron and manganese oxides.

The rocks may be divided into three types: pre-Cambrian schists that crop out in the northeast corner of the district, Paleozoic shales and limestones that occur in a central northwest-trending belt, and Tertiary and later lake and alluvial deposits that occupy the western part of the district.

The Paleozoic sedimentary rocks as mapped by Sahinen (1939, pp. 14–17) include the Cambrian Flathead and Wolsey formations and Upper Cambrian limestone and shale; Devonian dolomitic Jefferson limestone and shale and limestone of the Three Forks formation; and Carboniferous Madison limestone. These sedimentary rocks dip southwest, forming the west limb of a large anticline. Sahinen has mapped many small sills and dikes of granite in the pre-Cambrian schist and the adjacent lower Paleozoic sedimentary rocks.

Large faults cut the Paleozoic sedimentary rocks of the district and the pre-Cambrian schists east of the district. The traces of these faults are in general parallel to the trend of the Paleozoic rocks, and the faults appear to be parallel to the axial plane of the large anticline. Many smaller complementary fractures occur with the larger fractures, especially in the pre-Cambian schist.

The ore deposits in the Melrose district are mainly fracture fillings within both the large faults and the smaller parallel fractures. Some of the deposits are replacement bodies—chimneys or lenses—in limestones. Ore minerals apparently extend to a depth greater than 600 feet in some of the deposits, but none has been mined below this depth. Gold, the principal metal produced, has come mainly from high-grade, near-surface ore; silver, lead, and copper have been

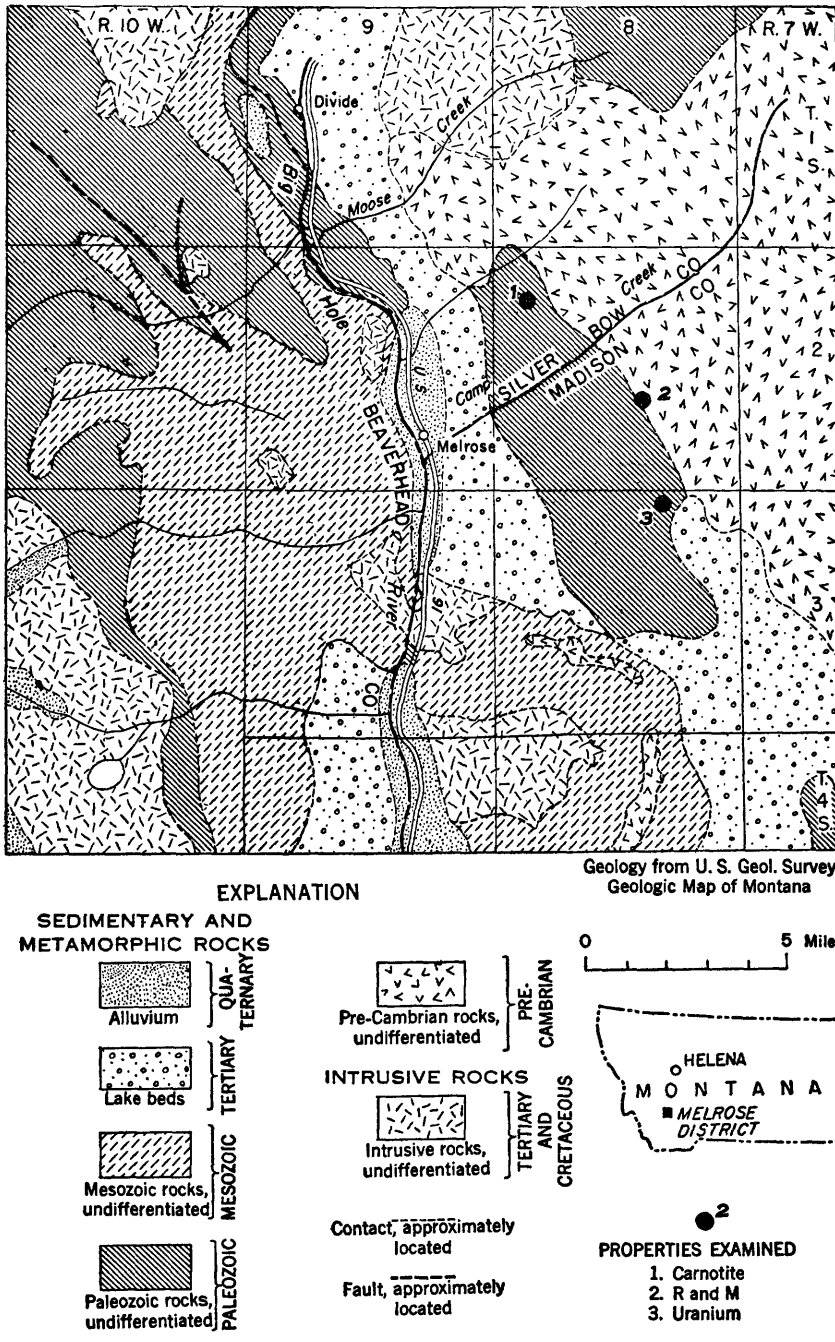


FIGURE 44.—Geologic and index maps of the Melrose district, Montana.

recovered from some of the deposits. Ore minerals include native gold, horn silver, galena, cerussite, and chalcopyrite; gangue minerals are mainly quarts, pyrite, and hydrous iron oxides.

CARNOTITE CLAIMS

The Carnotite claims are in secs. 7 and 17, T. 2 S., R. 8 W., Principal meridian, in Silver Bow County, about 3½ miles northeast of Melrose, Mont. They are owned by the Lively Mining Company, Box 96, Melrose, Mont. The workings consist of three prospect pits.

The pits are in lenticular chimneys of mineralized breccia along a fracture zone at the contact between dark-gray Upper Cambrian limestone and shale. The bedding of the limestone strikes N. 60° W. and dips 70° SW. The largest chimney is 50 feet long and 10 feet wide. All the chimneys strike northwest, parallel to the fracture zone.

The breccia consists of fragments of limestone and shale cemented by goethite, hematite, and white, fine-grained calcite. A heavy, black submetallic mineral appears to be associated with abnormal radioactivity. Geiger-Mueller counter readings ranged from background (4.0 division on the 0.2 scale) to twice background in the smaller chimney, and to nearly 4 times background in the largest chimney. A composite of chip samples from the largest chimney contains 0.016 percent equivalent uranium and 0.015 percent uranium.

R. AND M. CLAIMS

The R. and M. claims are about half a mile south of Camp Creek in secs. 22, 23, and 29, T. 2 S., R. 8 W., in Madison County, Mont. These claims are owned by R. F. Rowell and E. E. McLaughlin, addresses unknown. A bulldozer trench, 125 feet long and 7 feet deep, has been made across the ore body. The bulldozer cut is on a lens or chimney, 25 feet long and 3 feet wide, of breccia fragments and hydrous iron oxides in a fracture zone in shaly limestone.

Geiger-Mueller counter readings of approximately twice background (4.0 division on 0.2 scale) were recorded in the lens. A composite of chip samples of the lens contains 0.025 percent equivalent uranium and 0.035 percent uranium. The uranium content in excess of the equivalent uranium content suggests that uranium may be present in a secondary mineral and that a primary uraniferous deposit may occur beneath the oxidized zone.

URANIUM CLAIMS

The Uranium claims are near the southeast corner of the Melrose district, in sec. 4, T. 3 S., R. 8 W., Principal meridian, Madison County, Mont. They are owned by R. F. Rowell and E. E. McLaughlin, addresses unknown. A bulldozer cut, approximately 12 feet deep, has been made to the bottom of an old shaft.

The bulldozer cut exposes a lenticular, chimneylike deposit that trends N. 5° W. and dips 85° SW. in a fault cutting limestone. The chimney is 15 feet long and 4 feet wide, and continues beneath the bottom of the cut. The mineralized rock is a porous limestone breccia cemented by secondary calcite, hydrous iron and manganese oxides, and white to pale-blue clay

Maximum Geiger-Mueller counter readings of more than 4 times background were recorded on the chimney. A composite of chip samples across the deposit in the bottom of the cut contains 0.030 percent equivalent uranium and 0.022 percent uranium.

DEER CREEK DISTRICT, MONTANA

The Deer Creek district described in this paper is a north-trending area, 26 miles long and 12 miles wide, in the southern part of Beaverhead County, Mont. The east edge of the district is about 3 miles west of Dell, and the north end is about 5 miles south of Armstead, Mont. Seven radioactive deposits were examined in the Deer Creek and Big Sheep Creek areas, which are in the northern and southern parts of the district, respectively. One deposit, the Iola prospect, contains appreciable amounts of uranium; another deposit, on the Lookout no. 3 claim, contains appreciable amounts of thorium.

The geology of the area is shown in figure 45. Pre-Cambrian gneiss and schist are cut by pre-Cambrian granite pegmatite and surrounded by Carboniferous shale and limestone. These rocks are cut by stocks, dikes, and other masses of Tertiary rocks, and are locally overlain by Tertiary volcanic rocks. The larger valleys are filled with Tertiary lake deposits and more recent sediments. Small faults were seen in the areas examined.

DIVIDE NOS. 1 AND 2 CLAIMS

The Divide nos. 1 and 2 claims are on the ridge above the head of Limekiln Canyon in sec. 9, T. 11 S., R. 11 W., Principal meridian, about 23 miles by road southwest of Armstead, Mont. They are owned by P. O. Grimstead, Lima, Mont. A few small prospect pits have been dug on the property.

Five lenticular pegmatite dikes, the largest of which is 23 feet long and 9 feet wide, occur in pre-Cambrian quartz-biotite schist on the Divide nos. 1 and 2 claims. These pegmatites have an average grain size of one-eighth inch and consist of 30 to 55 percent plagioclase, 35 to 50 percent perthite, 10 to 20 percent quartz, 0.5 percent biotite, from a trace to 1 percent magnetite, and a trace of monazite.

Abnormal radioactivity as much as 10 times background (2.0 division on the 0.2 scale) is believed to be caused chiefly by the thorium in the monazite. A grab sample from one of the radioactive dikes contains 0.019 percent equivalent uranium and 0.005 percent uranium.

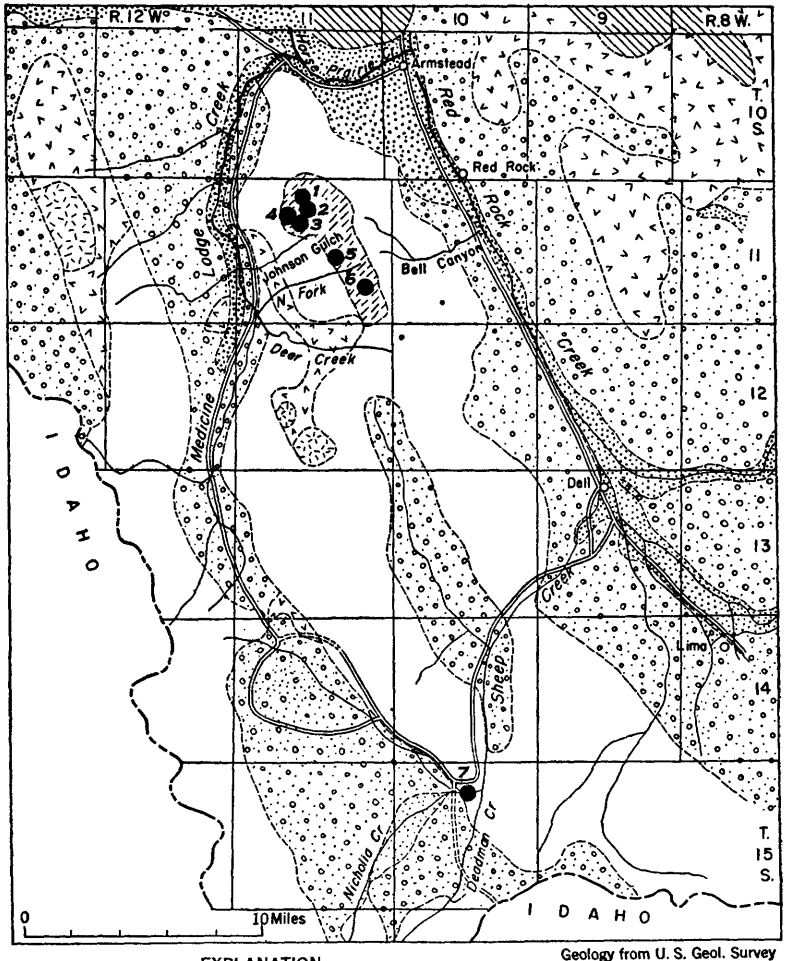


FIGURE 45.—Geologic and index maps of the Deer Creek district, Montana.

LOOKOUT NO. 1 CLAIM

The Lookout no. 1 claim, about half a mile north of the Divide no. 2 claim, is owned by R. H. Underwood, Dillon, Mont. Prospect work consists of one small pit.

On the Lookout no. 1 claim, three pegmatite dikes, trending N. 50°–75° E., cut pre-Cambrian quartz-biotite schist. The largest dike is 75 feet long and 12 feet wide. The pegmatites have an average grain size of one-quarter inch and contain about 50 percent microcline, 33 percent plagioclase, 15 percent quartz, 2 percent magnetite, and a trace of monazite. A selected sample from radioactive pegmatite in the prospect pit contains 0.033 percent equivalent uranium and 0.003 percent uranium.

PEGMATITE ON MONTANA STATE LAND

A radioactive pegmatite dike is in the SE¼ sec. 9, T. 11 S., R. 11 W., near the head of Johnson Gulch, a quarter of a mile south of the Divide no. 1 claim. No work has been done on the property, which is believed to be leased from the State of Montana by D. E. Metlen of Armstead, Mont.

The pegmatite dike, 35 feet long and 4 feet wide, strikes N. 33° W. and dips 78° NE., cutting pre-Cambrian hornblende gneiss. The pegmatite has an average grain size of one-half inch and relatively uniform composition of about 55 percent plagioclase, 20 percent perthite, 20 percent magnetite, and 5 percent quartz. Monazite is believed to be present but was not found.

A grab sample from the dike contains 0.016 percent equivalent uranium and 0.002 percent uranium. Most of the radioactivity is believed to be due to thorium, probably in monazite.

GRAY GOOSE CLAIMS

The three Gray Goose claims are in secs. 21 and 22, T. 11 S., R. 11 W., Principal meridian, between the North Fork of Deer Creek and Bell Canyon. No record of the ownership of the claims has been found. Four bulldozer trenches were made across the dikes by R. A. Wellborn of Armstead, Mont.

Radioactive material occurs in a west-trending belt of biotite diorite and granite pegmatite dikes, metamorphosed shales, and quartz veins. The metamorphosed shale, in general, strikes N. 23° W. and dips 18° SW.

The most numerous dikes consist of biotite diorite, biotite-hypersthene diorite, and pyroxenite. These dikes, late Cretaceous or Tertiary in age, strike N. 4°–40° W., and dip 22°–50° NE. They are less than 50 feet long, a few inches to 1 foot thick, and are separated by intervals of from 2 to 170 feet of metamorphosed shale. The grain

size of the dikes is from 1/16 to 1½ inches; in general the biotite diorite has the coarsest texture. The dike rocks contain andesine, biotite, hypersthene, anthophyllite, hornblende, chlorite, and quartz.

Granite pegmatite and aplite dikes are exposed at the east end of the belt. One 6-inch granite pegmatite dike, exposed in a bulldozer cut at the head of Bell Canyon, occurs with diorite dikes and altered shale in a fault zone. The pegmatite dike strikes N. 57° W., and dips 60° SW. Microcline, quartz and plagioclase are the dominant minerals and have an average grain size of 1½ inches.

Quartz veins, containing anthophyllite, limonite, calcite, and plagioclase are associated with the dikes. The veins trend N. 28° W.–N. 85° E. They are less than 50 feet in exposed length and from 4 inches to 2 feet in thickness.

Glaucophane schist, biotite schist, anthophyllite schist, and garnet-quartz schist occur as contact-metamorphic layers parallel to and associated with the mafic dikes. The highest radioactivity is found in the diorite pegmatite dikes. Kiyoko Onoda of the U. S. Geological Survey Trace Elements Section Washington Laboratory has determined that the radioactivity in a specimen from a diorite pegmatite dike is principally from monazite and allanite. The chief radioactive mineral of the heavy-mineral fraction is monazite. The allanite is closely associated with the biotite. Spectrographic analyses of the monazite and allanite give the following results:

Radioactive mineral	Major constituents	Minor constituents	Trace constituents
Monazite	Th, Ce, P	La, Si	Y, Ca, Mg, Pb.
Allanite	Fe, Mg, Si	Th, Ce, La, P, Ca, Al, Mn	Y, Ti, Pb.

Some biotite-rich parts of the contact-metamorphic zones, from 1 foot to 45 feet thick, are abnormally radioactive. Two quartz veins, 1 foot and 2 feet thick and less than 50 feet long, and a 6-inch granite pegmatite dike contain radioactive material. Monazite is believed to be the source of most of the radioactivity.

Table 5 indicates the percent of equivalent uranium, uranium, and calculated thoria in samples from the Gray Goose claims. The two samples from biotite diorite pegmatite dikes contain 0.025 and 0.053 percent equivalent uranium, and are calculated to contain about 0.1 and 0.2 percent thoria, respectively. A sample of biotite schist from a bulldozer trench contains 0.040 percent equivalent uranium and is calculated to contain about 0.2 percent thoria. A sample of quartz vein contained 0.032 percent equivalent uranium and is calculated to contain about 0.1 percent thoria. All samples contain negligible amounts of uranium.

TABLE 5.—*Equivalent uranium, uranium, and calculated thoria, in percent, Gray Goose claim, Beaverhead County, Mont.*

Sample no.	Location	Description	Equivalent uranium	Uranium	Calculated thoria
AFT-S41-50	Small pit, Gray Goose no. 1 claim.	Grab sample, biotite diorite pegmatite dike.	0.205	0.002	0.1
AFT-S42-50	do	do	.053	.002	.2
AFT-S44-50	Bulldozer trench, Gray Goose no. 1 claim.	Grab sample, biotite schist	.003	.001	.01
AFT-S43-50	do	Grab sample, quartz vein	.032	.003	.1
AFT-S45-50	Small pit, Gray Goose no. 2 claim.	Grab sample, soil above a biotite-rich contact metamorphic-zone.	.034	.002	.1
AFT-S51-50	Bulldozer trench, Gray Goose no. 2 claim.	Grab sample, biotite schist	.040	.003	.2
AFT-S50-50	do	Grab sample, granite pegmatite.	.014	.002	.05

LOOKOUT NO. 3 CLAIM

The Lookout no. 3 claim is near the head of Kissick Canyon, in sec. 9, T. 11 S., R. 11 W., Principal meridian. The claim is owned by R. H. Underwood of Dillon, Mont. Prospect work consists of a very small pit.

The pit is in a small, lenticular, hydrothermal carbonate vein in gneissic hornblende diorite, thought to be pre-Cambrian in age. The foliation of the diorite strikes N. 60° E. and dips 80° NE. The vein, which is 40 feet long and 10 feet wide, strikes parallel to the foliation of the diorite. The vein consists of pink to salmon, fine-grained calcite in which very small crystals of pyrite and chalcopyrite occur along small fractures. A grab sample of the vein material contains 0.11 percent equivalent uranium and 0.006 percent uranium. Chemical analysis indicates 0.24 percent ThO_2 and 2.71 percent rare earths.

POISON LAKE LODE CLAIM

The Poison Lake Lode claim is in sec. 26, T. 11 S., R. 11 W., Principal meridian, on the divide overlooking a southern fork of Bell Canyon, about 22 miles by road southwest of Armstead, Mont. No record of the ownership of the claim has been found, and no discovery work has been done.

The Poison Lake Lode deposit consists of abnormally radioactive, hydrothermal fluorite veins in altered Carboniferous limestone and Tertiary aplite dikes. Fine-grained gray limestone a few hundred feet west of the fluorite deposit is the only unaltered rock noted in the immediate area.

Fluorite veins comprise more than 5 percent of a northwest-trending area more than 600 feet long and 200 feet wide that roughly parallels the divide. The veins trend generally northeast, cutting across the mineralized area, and dip steeply northwest or southeast. They are apparently associated with highly altered aplite dikes. Most of the

veins are less than 10 feet long and 3 inches to 1 foot thick, but one vein was more than 100 feet long and 75 feet wide.

Fluorite constitutes about 1 percent of the mineralized area. The purple fluorite crystals, less than 0.1 mm across, are disseminated in a fine-grained mixture of calcite, limonite, and quartz in the veins. Fresh surfaces of the veins are purple, but weathered surfaces are brown.

The smaller veins, less than 1 foot thick, contain 30 to 65 percent fluorite, 10 to 50 percent quartz, 20 to 40 percent limonite, and 5 to 30 percent calcite. The largest vein is made up of 55 percent calcite, 40 percent limonite, 4 percent quartz, and less than 1 percent fluorite. No metallic minerals have been noted in the veins, but the limonite is believed to have been derived from pyrite.

The veins cut green, pink, and red altered limestone and aplite. The aplite is about one-sixteenth inch in grain size and is composed of calcite, quartz, feldspar, fluorite, hematite, and chlorite or sericite.

Alteration is intense and widespread throughout the mineralized area, and altered aplite is difficult to distinguish from altered limestone. The altered rock has weathered to a green, with some hematite stain.

Spectrographic analysis of selected fluorite-bearing vein material by Tennyson Myers of the U. S. Geological Survey Trace Elements Section Denver Laboratory indicates the following elements, in percent:

Sample no.	More than 10.0	1.0–10.0	0.1–1.0	0.01–0.1	0.001–0.01	0.0001–0.001	Unmeasurable quantities
AFT-279-50	Ca	Ba	Al, Sr, Y, La.	Ti, Th	Pb, Zr, Cu, V, Mg.	Ag, Mn, Bi.	Cr, U, Na, Mo, Be.

Looked for but not found: B, Ni, Zn, Co, Ga, Tl, Hg, Re, As, Cd, Sb, Sc, Sn.

Table 6 shows the equivalent uranium and the uranium content of the four samples collected. A large part of the radioactivity is probably due to thorium. The most radioactive sample contains 0.024 percent equivalent uranium and 0.001 percent uranium, and is calculated to contain about 0.1 percent thoria.

TABLE 6.—*Equivalent uranium and uranium, in percent, Poison Lake Lode fluorite deposit, Beaverhead County, Mont.*

Sample no.	Location	Description	Equivalent uranium	Uranium
AFT-S56-50	Large fluorite vein	Grab sample, vein material	0.011	0.001
AFT-S57-50	Small fluorite vein	do	.022	.001
AFT-S58-50	Near small fluorite vein	6-foot chip sample across altered limestone.	.008	.001
AFT-S59-50	8-inch fluorite vein	Grab sample vein material	.024	.001

IOLA PROSPECT

The Iola prospect is in sec. 9, T. 15 S., R. 10 W., Principal meridian, about 150 feet above the valley floor near the junction of Big Sheep Creek and Nicholia Creek, 18 miles southwest of Dell, Mont. The property is an unpatented claim owned by P. H. Peterson of Lima, Mont.

The mine workings consist of a 150-foot adit, a 42-foot vertical shaft with a short drift extending northwest from the bottom, and an 8-foot prospect pit. The adit has been driven toward a radioactive vein, 200 feet east of the portal. The shaft is about 20 feet east of the vein. The prospect pit is the only working that cuts the radioactive vein at the surface.

The workings expose several quartz veins. They are part of a group of quartz veins in a broad contact zone between Carboniferous (?) limestone and younger granite. The limestone is a fine-grained, gray, closely-fractured rock with limonitic stains on the fractures. The bedding, which strikes N. 12°–50° E. and dips 10°–16° NW., is locally disrupted by faulting. A medium-grained red granite, rich in biotite, crops out about 300 yards northwest of the shaft.

The contact zone trends northwest and is at least 1,000 feet long and more than 100 feet wide. The limestone in this zone has been altered locally to a medium-grained white marble containing graphite. The marble and graphite are in discontinuous layers less than 100 feet in exposed length and from a few inches to 10 feet thick.

Quartz veins in the contact zone trend northwest and appear to dip southwestward. They are 50 to 150 feet long and 3 to 12 feet wide. Two of these veins are abnormally radioactive. One of the radioactive veins, trending N. 42° W., has an exposed length of 150 feet and an average thickness of 5 feet. This vein is best exposed in the prospect pit where it strikes N. 35° E., dips 45° NW., and is 3 feet thick. It is composed of more than 99 percent quartz and a small amount of limonite and a few small lenses containing malachite. In the pit, graphite was found in the contact zone adjacent to the footwall of the vein.

The other radioactive vein, which does not crop out and is obscured by timbering in the shaft, is said by the owner to be thinner. Pieces of this vein, found on the dump around the shaft, are abnormally radioactive. They consist of about 95 percent quartz, 4 percent limonite, and 1 percent malachite and azurite. Some silver-bearing minerals and copper have been reported by the owner.

A trace of fluorite occurs in small discontinuous quartz veins in the crosscut. Veins, a fraction of an inch to 2 inches wide, consisting mainly of anglesite and minor amounts of galena and calcite, were noted a few hundred yards north of the shaft.

A grab sample of the limonitic quartz vein, collected from the shaft dump, contains 0.037 percent equivalent uranium and 0.050 percent uranium. The high ratio of uranium to equivalent uranium suggests that secondary uranium minerals may be present.

The maximum Geiger-Mueller counter reading on the vein material on the dump and from the smaller vein in the shaft was 5 times background (2.0 division on the 0.2 scale), and on the surface of the larger vein was 3½ times background. The larger vein was not sampled, but the Geiger-counter readings indicate that it is slightly less radioactive.

The Geiger-counter readings ranged from 3½ to 9 times background in the bottom of the shaft and in the drift from it. The counter continued to give these higher readings for several minutes after return to surface, indicating the presence of radon gas in the shaft and drift.

LEMHI PASS DISTRICT, IDAHO AND MONTANA

The Lemhi Pass district is an area about 20 miles long and 5 miles wide extending eastward from McDevitt Creek near Tendoy, Idaho, to the junction of North and South Frying Pan Creeks, in Beaverhead County, Mont. Eleven deposits were examined for uranium and thorium in the district, and all of the deposits were found to contain thorium.

Umpleby (1913, pp. 30–32), has mapped Paleozoic rocks in much of the area south of Lemhi Pass, and Vhay [12] noted a southward-dipping conglomerate bed at the pass which may be basal Cambrian.

Most of the rocks in the area are believed to be pre-Cambrian as shown in figures 46 and 47. The rocks are probably a part of the Belt series, and consist of fair to well foliated, moderately metamorphosed sandstones and argillites. The beds strike N. 30°–76° W., and dip 16° to 60° NE. Jointing is prominent, but no general joint pattern was noted.

Tertiary basalts and rhyolites overlie the pre-Cambrian rocks along Agency Creek, near the summit of Lemhi Pass, and south of South Frying Pan Creek. Tertiary lake deposits of stratified gravels, sands, and clays crop out in the Lemhi River valley in the western part of the district.

Copper veins and quartz-hematite veins occur as fracture fillings in the rocks of the Belt series. The copper veins near Agency Creek, in Idaho, range from a few inches to 10 feet wide; one is more than 500 feet long. Ore minerals include bornite, chalcopyrite, chalcocite, cuprite, malachite, azurite, and gold and silver minerals; gangue minerals include quartz, pyrite, hematite, and hydrous iron oxide. The radioactivity of the copper veins is comparable to that of thorite-

[12] See p. 157; footnote 1 (p. 10).

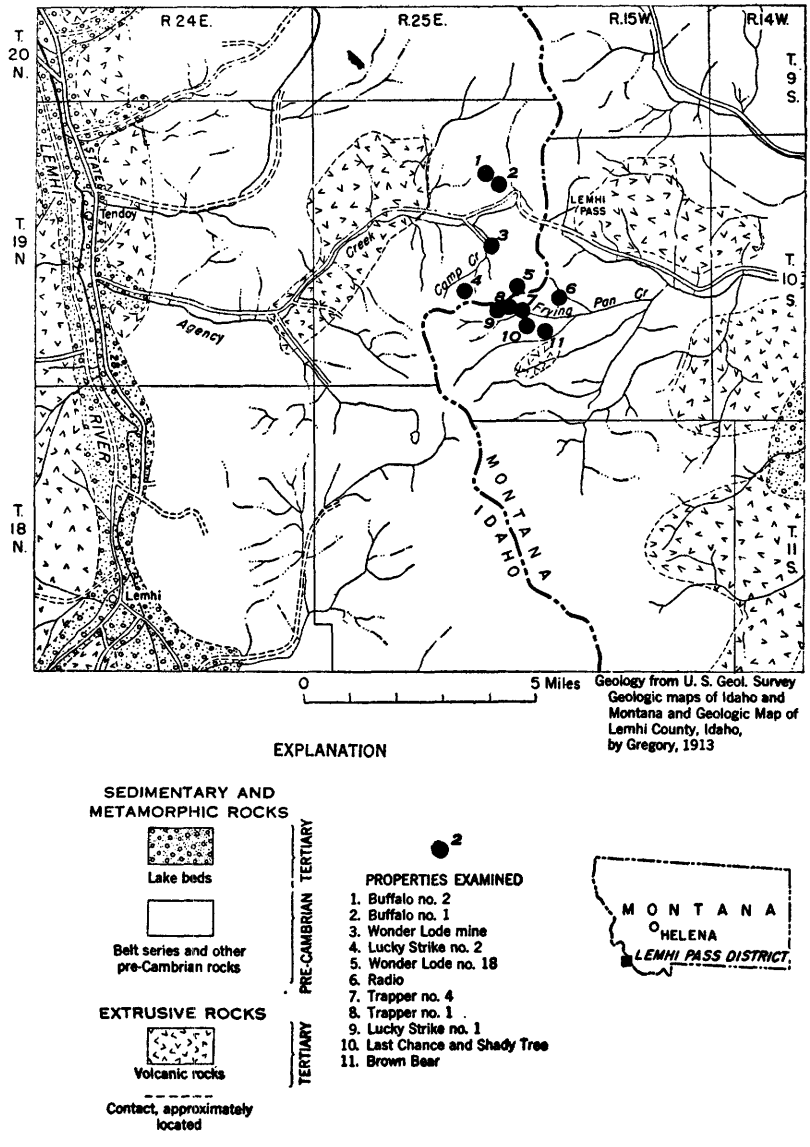


FIGURE 46.—Geologic and index maps of the Lemhi Pass district, Idaho and Montana.

bearing quartz-hematite veins on North and South Frying Pan Creeks. Samples contain as much as 0.57 percent equivalent uranium, 0.008 percent uranium, and 3.0 percent calculated thoria (based on the assumption that all the radioactivity is caused by thorium and its decay products).

The quartz-hematite veins range from less than 1 foot to 50 feet wide, and from 10 feet to more than 700 feet long. These veins are

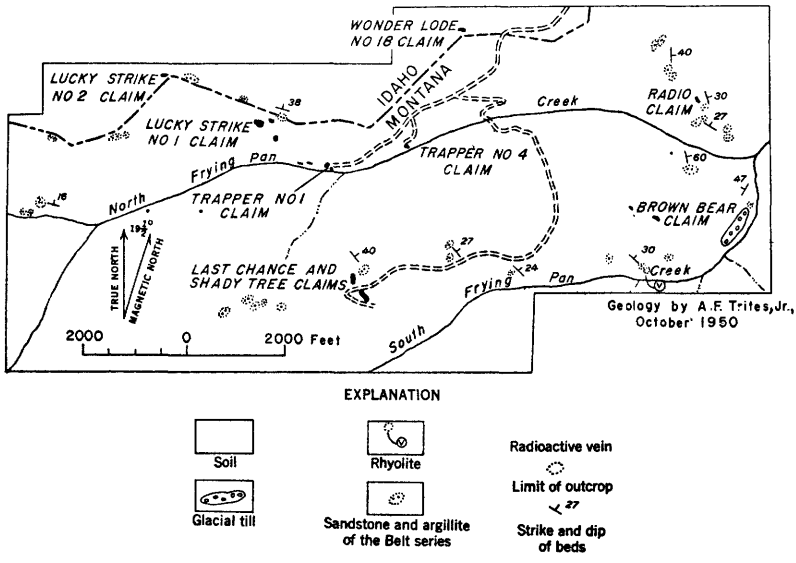


FIGURE 47.—Geologic map of the Frying Pan Creek area, Beaverhead County, Mont.

reddish brown, whether fresh or weathered, and are more resistant than the country rock, forming bold outcrops. Quartz, hematite, goethite, chalcedony, thorite, and barite are the principal minerals in these veins, and a few green copper stains have been noted.

Most of the radioactivity is due to thorium in the thorite. Minor thorium is also present in the fine-grained mixture of iron oxides, and may occur as hydrothorite, an alteration product of the thorite. Samples from the quartz-hematite veins contained as much as 1.25 percent equivalent uranium, 0.008 percent uranium, and 6.6 percent calculated thoria. The rare-earth metals yttrium, cerium, samarium, neodymium, gadolinium, and lanthanum, were found by spectrographic analysis of both the heavy and light mineral fractions of the samples.

WONDER LODE MINE

The Wonder Lode mine is in sec. 15, T. 19 N., R. 25 E., Boise meridian, on Camp Gulch, a tributary of Agency Creek, Lemhi County, Idaho. The mine is on a series of unpatented claims owned by G. E. Shoup of Salmon, Idaho. The workings consist of five caved adits and two accessible adits that are 50 and 75 feet long.

The Wonder Lode mine is on a copper-bearing quartz vein cutting quartzite and argillite of the Belt series. The vein, which strikes N. 76° E. and dips 80° NW., has been exposed for more than 500 feet and has an average width of 3 feet. Ore minerals include thorite, bornite, chalcopyrite, malachite, and azurite as lenses in a gangue of quartz, pyrite, and hydrous iron oxides. The main radioactive mineral is

probably thorite, as in the quartz-hematite veins a few hundred yards east of the Wonder Lode mine. The argillite adjacent to the vein is altered to clay minerals and is stained red, yellow, and green. Table 7 shows the equivalent uranium, uranium, and calculated thoria content of samples from the Wonder Lode vein.

TABLE 7.—*Equivalent uranium, uranium, and calculated thoria, in percent, Wonder Lode mine, Lemhi County, Idaho*

Sample no.	Location	Description	Equivalent uranium	Uranium	Calculated thoria
AFT-S18-50	Adit 1 west	Chip sample across vein	0.031	0.003	0.15
AFT-S19-50	Adit 2 west	do	.12	.002	.6
AFT-S20-50	Adit 3 west	do	.12	.004	.6
AFT-S21-50	Adit 1 east	do	.57	.002	3.0
Average			.21	.003	1.1

BUFFALO NO. 1 CLAIM

The Buffalo no. 1 claim is in sec. 10, T. 19 N., R. 25 E., Boise meridian, on the west side of Agency Creek about 300 feet above the road, in Lemhi County, Idaho. The claim is owned by G. E. Shoup of Salmon, Idaho. A small, L-shaped prospect pit, 25 feet long and 4 feet deep, has been dug on the property.

The open cut exposes one of a series of quartz-hematite veins that cut pre-Cambrian quartzite and quartz-muscovite-biotite schist of the Belt series. Foliation of the schist strikes N. 29° E. and dips 35° NW. The quartz-hematite veins crop out in a northwest-trending area about 400 feet long and 150 feet wide. The irregular vein in the open cut is about 5 inches wide and is approximately conformable to the foliation. The other veins, forming about 1 percent of the area, are less than 1 foot wide and from 10 to 25 feet long.

The veins are made up of 70 percent quartz and 30 percent specular hematite, magnetite, and hydrous iron oxides. Most of the abnormal radioactivity is believed to be due to thorite. One sample of selected material from the vein in the prospect pit contains 0.085 percent equivalent uranium and 0.006 percent uranium, and is calculated to contain about 0.4 percent thoria.

BUFFALO NO. 2 CLAIM

The Buffalo no. 2 claim is in sec. 10, T. 19 N., R. 25 E. Boise meridian, on the hillside west of Agency Creek, in Lemhi County, Idaho. The property is owned by G. E. Shoup of Salmon, Idaho. Mine workings consist of two caved shafts and one caved adit. The main shaft near the north end of the vein outcrop is said by Mr. Shoup to have been 230 feet deep.

The claim is on a copper-bearing quartz vein that cuts metamorphosed sandstones and argillites of the Belt series and a Tertiary rhyolite breccia dike. It is said that the vein is 2,400 feet long and 2 to 4 feet wide. It is exposed at the surface only at the southeast opening and at the collar of the caved shaft where it strikes N. 30° W. and dips 80° NE.

More than 600 tons of ore containing 10 to 14 percent copper and some silver and gold were reported by Mr. Shoup to have been mined through the main shaft. Malachite, bornite, and chalcopyrite are reported to have been the principal ore minerals. Most of the vein material seen consists of quartz, and considerable hematite and hydrous iron and manganese oxides. A small amount of malachite was noted on the dump at the main shaft. Most of the abnormal radioactivity (table 8) is believed to be due to thorium, possibly in thorite.

TABLE 8.—*Equivalent uranium, uranium, and calculated thoria, in percent, Buffalo no. 2 claim, Lemhi County, Idaho*

Sample no.	Location	Description	Equivalent uranium	Uranium	Calculated thoria
AFT-S12-50	Caved collar of main shaft.	Grab sample of soil adjacent to rhyolite breccia dike.	0.008	0.003	0.03
AFT-S13-50	do	Chip sample across rhyolite breccia dike.	.003	.001	.01
AFT-S14-50	do	Chip sample across quartz vein.	.003	.003	.00
AFT-S15-50	On dump around caved shaft northeast of main shaft.	Selected sample of vein	.18	.008	.8

WONDER LODE NO. 18 CLAIM

The Wonder Lode no. 18 claim is in sec. 26, T. 19 N., R. 25 E., Boise meridian, less than 100 yards from the Continental Divide in Lemhi County, Idaho. The ownership of the claim is not known.

The claim in on a quartz-hematite vein cutting micaceous quartzite of the pre-Cambrian Belt series. The vein strikes N. 76° E. and dips 80° SE.; it is 2 to 5 feet wide and crops out for more than 200 feet. Massive white quartz in the vein is cut by small discontinuous, radioactive, red hematitic veinlets, 1 to 2 inches wide, in a 10-foot interval near the northeast end. A large part of the abnormal radioactivity, which is confined to this 10-foot section of the vein, is believed to be from thorite associated with the fine-grained hematite. A selected sample of this radioactive hematitic vein contains 0.19 percent equivalent uranium, 0.004 percent uranium, and 1.0 percent calculated thoria.

LUCKY STRIKE NO. 1 CLAIM

The Lucky Strike no. 1 claim is on the north side of North Frying Pan Creek in sec. 20, T. 10 S., R. 15 W., Beaverhead County, Mont. The claim is owned by R. G. Denny of Salmon, Idaho. Two small propect pits have been dug on the property.

The claim is on a radioactive quartz-hematite vein cutting sandstone and argillite. The vein has a westerly trend and may be the south-faulted extension of the vein on the Trapper no. 1 claim; it is about 32 feet long and 10 feet wide in surface exposure. The vein consists of white and pink quartz cut be veinlets of specular hematite and goethite. Thorite is believed to be present. A sample of the Lucky Strike no. 1 vein contains 0.021 percent equivalent uranium, 0.002 percent uranium, and is calculated to contain 0.1 percent thoria.

LUCKY STRIKE NO. 2 CLAIM

The Lucky Strike no. 2 claim is on the Continental Divide in sec. 27, T. 19 N., R. 25 E., Boise meridian, Lehmi County, Idaho, about 30 feet from the Montana State line. The property is an unpatented claim, the ownership of which is not known. The workings consist of two prospect pits, one on a quartz-hematite vein and the other in country rock northwest of the vein.

The quartz-hematite vein cuts metamorphosed argillite and sandstone of the pre-Cambrian Belt series. The beds strike generally N. 76° W. and dip 16°–38° NE. Muscovite and chlorite in the beds impart a foliation that strikes N. 72° W. and dips 32° SW.

The vein strikes west and dips 52° N. where it is exposed in the pit. It crops out for 50 feet, and has an average width of 10 feet. The vein consists of light-brown brecciated quartz cut by many intersecting specular hematite veinlets, from knife-edge to ½ inch thick. Hematite forms about 40 percent of the rock. A large part of the radioactivity is believed to be due to thorite.

A grab sample from the vein contains 0.020 percent equivalent uranium, 0.001 percent uranium, and 0.1 percent calculated thoria. The entire vein is estimated to contain about 0.1 percent thoria.

TRAPPER NO. 1 CLAIM

The Trapper no. 1 claim is on the north side of North Frying Pan Creek, at an altitude of about 7,100 feet, in sec. 20, T. 10 S., R. 15 W., Principal meridian, in Beaverhead County, Mont. The claim is owned by H. B. McKenney and W. G. Armeson of Armstead, Mont. During the summer of 1950, the owners prospected the radioactive veins by diamond drilling more than 250 feet and bulldozing 1,500 feet of trenches, as shown in plate 25.

The argillite and fine-grained sandstone beds exposed in the bulldozer trenches strike N. 40°–50° W. and dip approximately 30° NE. These rocks, as well as the veins, are closely jointed; the most conspicuous joints strike northwest and dip steeply northeast. Small quartz veinlets, less than 1 inch thick, cut the argillite and sandstone.

One large vein and at least three small veins or lenses occur at the Trapper no. 1 claim. Segments of the large vein are exposed in the largest outcrop, 60 feet long and 40 feet wide, and a smaller outcrop at the discovery pit. A third, smaller segment, southeast of the discovery pit, is now covered by dump. A smaller vein or lens is exposed in an old prospect pit 200 feet east of the largest outcrop. Other small lenses have been exposed by the bulldozer trenches above and east of the largest outcrop.

The footwall contact of the largest vein strikes N. 79° W. and dips 64° SW., where it is exposed in the bulldozer trench above the largest outcrop. The hanging wall contact forms the lower, south surface of the largest outcrop, and is exposed in the bulldozer trench at the foot of the outcrop where it is overlain by a 4-inch, nonradioactive, limonite-stained quartz vein. This northern quartz-hematite vein segment is about 100 feet long.

The two southern segments of this large vein have been moved southward along two shear zones. One 10-foot shear zone strikes N. 10°–17° W. and dips 85° NE. where it is exposed in the bulldozer cut below the largest outcrop. The other shear zone is exposed east of the outcrop at the discovery pit, where it is 7 feet wide, strikes N. 21° W., and dips 78° NE. The 55-foot vein segment at the discovery pit has been moved southward about 80 feet along the eastern shear zone, and a 45-foot segment now covered by the dump, was moved southward about 20 feet along the eastern shear zone. Conspicuous fracture surfaces in the outcrop at the discovery pit, and in the northeast corner of the large outcrop, are parallel to the western shear zones. The combined length of these three segments of the largest vein is 200 feet. The average thickness of the northern vein segment is 30 feet and of the two southern vein segments is 15 feet.

The veins are composed of fractured quartz cut by veinlets of specular hematite and goethite. Kiyoko Onoda of the Geological Survey has identified barite and thorite in two samples taken from the largest vein.

Spectrographic analyses of bulk samples of the heavy and the light minerals from the veins are given below:

Heavy minerals, in percent

Sample no.	More than 10.0	1.0–10.0	0.1–1.0	0.01–0.1	0.001–0.01	0.0001–0.001
AFT-311-50	Fe, Si	Th, Y	Ce, Al, Am, Nd, Gd, Cu, Pb, Ba.	Mg, Mn, U, La, Cu, Ti, Ni, Sr, Cr.	None	Ag, Be.

Light minerals, in percent

Sample no.	More than 10.0	1.0–10.0	0.1–1.0	0.01–0.1	0.001–0.01	0.0001–0.001
AFT-311-50	Si	Fe, Th	Al, Ce, Ba, Gd, Nd, Sm, Mg.	La, Ca, Y, Mn, Pb, V, Sr, Cu, Ni, Ti.	Cr	Ag, B.

Radiometric analyses indicate that the heavy minerals contain most of the thorium. Most of the radioactivity is from thorite, and some is possibly from secondary thorium oxides.

The equivalent uranium, uranium, thoria, and calculated thoria content of the samples collected from the Trapper no. 1 claim are given in table 9. Uranium is low, in no sample exceeding 0.006 percent. Samples from the vein segment at the discovery pit contain between 0.56 and 0.68 percent ThO_2. These chemical analyses closely approximated the thoria content calculated from equivalent uranium and uranium determinations. The average grade of the vein segment

TABLE 9.—*Equivalent uranium, uranium, thoria, and calculated thoria, in percent Trapper no. 1 claim, Beaverhead County, Mont.*

Sample No.	Location	Description	Equivalent uranium	Uranium	Thoria	Calculated thoria
AFT-S37-50	Large outcrop	Composite chip sample of south-dipping fracture surfaces in vein.	0.023	0.002		0.1
AFT-S36-50	Northeast corner, large outcrop.	Chip sample of vein	.12	.006	0.66	.6
AFT-S38-50	Bulldozer trench near discovery pit.	Chip sample across east part of vein.	.13	.006	.56	.7
AFT-S39-50	Discovery pit	Chip sample across west part of vein.	.13	.006	.68	.7
AFT-S40-50	Large outcrop	Composite of chip samples of surface of vein.	.029	.002		.1
AFT-S46-50	Bulldozer trench below large outcrop.	Composite of chip samples of hanging wall of vein.	.014	.001		.07
AFT-S47-50	Upper bulldozer trench	Chip sample across vein	.025	.001		.1
AFT-S48-50	Bulldozer trench below large outcrop.	Grab sample of gouge on hanging wall of quartz-limonite vein.	.004	.002		.01
AFT-S49-50	Upper bulldozer trench	Grab sample of vein	.074	.002		.4

at the discovery pit is believed to be about 0.6 percent thoria and 0.006 percent uranium; the vein segment at the large outcrop is estimated to contain 0.1 percent thoria and 0.022 percent uranium.

TRAPPER NO. 4 CLAIM

The Trapper no. 4 claim is on the hillside north of North Frying Pan Creek in sec. 20, T. 10 S., R. 15 W., Principal meridian, in Beaverhead County, Mont. The southern end of the claim is on the creek at an altitude of 6,880 feet. The claim is owned by H. B. McKenney and W. G. Armeson. The workings consist of three prospect pits, the largest of which is the discovery pit about 12 feet deep, and a bulldozer trench about 140 feet long and 12 feet deep.

A thorium-bearing quartz-hematite vein in metamorphosed sandstone is exposed on the Trapper no. 4 claim (fig. 48). Exposures of sandstone are poor; the only known outcrop is immediately east of the discovery pit. The sandstone strikes N. 70° W. and dips 10° NE. Conspicuous jointing in the sandstone strikes N. 45° W. and dips 66° SW. in the bulldozer trench and strikes N. 55° W. and dips 85° SW. in the discovery pit.

The bulldozer trench exposes two wide fault or shear zones, containing 8 to 10 feet of gouge. The northern zone strikes N. 30° W. and is apparently joined by or intersects the southern zone that strikes N. 55° W. and dips 85° SW. at the north wall of the pit in the trench. Another fault, striking N. 52° W. and dipping 72° NE., is exposed in the discovery pit where it consists of a gouge zone 3 to 6 inches thick.

A radioactive quartz-hematite vein, 1½ feet thick, crops out on the footwall of the fault in the discovery pit. This vein has been cut in the old, southernmost prospect pit, 80 feet southeast of the discovery pit, but it is not exposed in the bulldozer trench. Abnormal radioactivity along the east wall of the trench suggests the presence of the vein beyond this wall. Abnormal radioactivity along a narrow strip, 125 feet long, northwest of the bulldozer trench, is believed to indicate the extension of the vein. The total length of the vein is therefore probably about 600 feet.

The radioactive vein is reddish and is composed of quartz cut by veinlets of specular hematite, earthy hematite, and goethite. It is similar in appearance to the veins on the Trapper no. 1 claim that contain barite and thorite. Secondary hydrous iron and possibly secondary thorium minerals have been formed along the two fault zones cut by the bulldozer trench.

A chip sample across the radioactive vein in the discovery pit contains 0.10 percent equivalent uranium, 0.006 percent uranium, and 0.5 percent calculated thoria. The fault gouge is estimated to contain

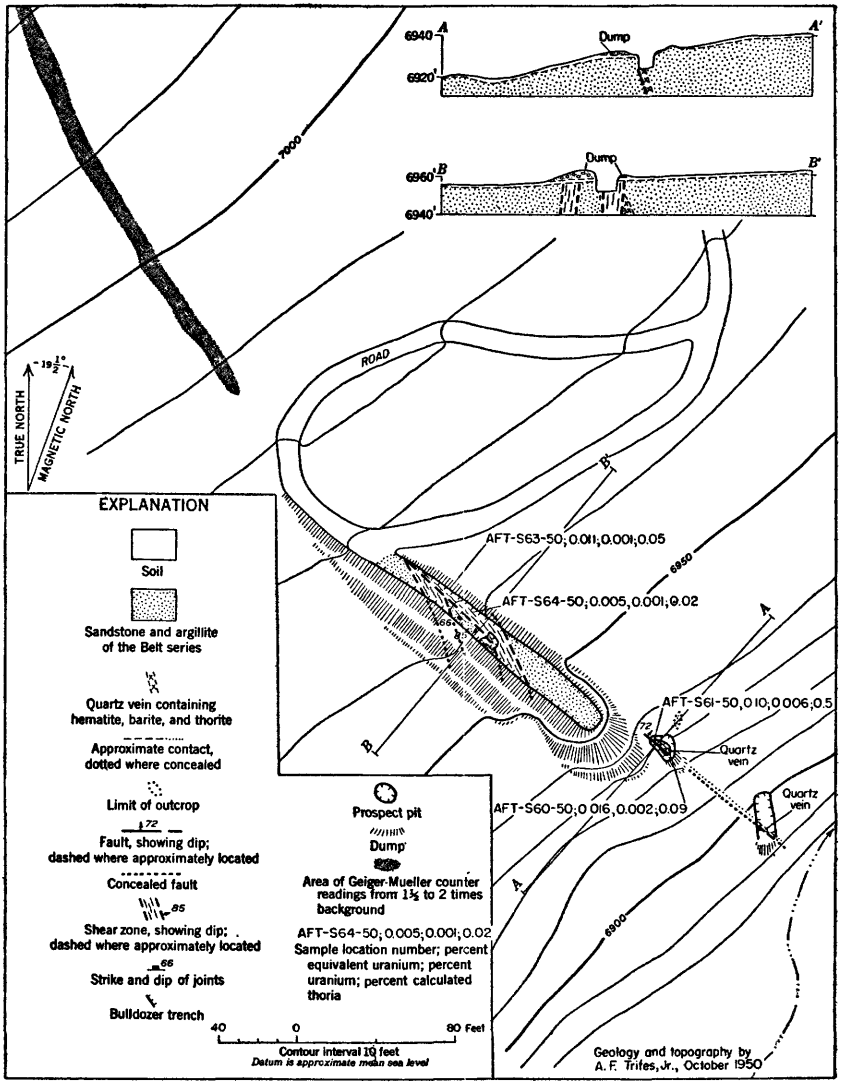


FIGURE 48.—Geologic map and sections of the Trapper no. 4 claim, Beaverhead County, Mont.

a maximum of 0.09 percent thoria. The equivalent uranium, uranium, and calculated thoria content of samples are given in table 10.

RADIO CLAIM

The Radio claim, on the north side of North Frying Pan Creek, is in sec. 21, T. 10 S., R. 15 W., Principal meridian, in Beaverhead County, Mont. No record is available of the ownership of the property. Prospect work consists of an 8-foot pit in a radioactive quartz-hematite vein.

TABLE 10.—*Equivalent uranium, uranium, and calculated thoria, in percent, Trapper no. 4 claim, Beaverhead County, Mont.*

Sample no.	Location	Description	Equivalent uranium	Uranium	Calculated thoria
AFT-S60-50	Discovery pit	Grab sample of fault gouge	0.016	0.002	0.09
AFT-S61-50	do	Chip sample across vein	.10	.006	.5
AFT-S63-50	East wall of bulldozer trench.	15-foot chip sample across fault gouge.	.011	.001	.05
AFT-S64-50	Bulldozer trench floor	Grab sample of iron oxide streaks in fault zone.	.005	.001	.02

The thorium-bearing quartz-hematite vein on the Radio claim cuts quartzite and schist of the pre-Cambrian Belt series. It strikes N. 30° W., and dips 30° NE. at the present pit. Float from the vein can be traced 200 feet southeast of the pit.

The principal minerals are quartz, hematite, and hydrous iron oxides. Malachite occurs as small spots distributed throughout the vein prospect pit. The abnormal radioactivity is believed to be from thorite. A grab sample of the vein material on the dump contains 0.26 percent equivalent uranium and 0.008 percent uranium, and is calculated to contain 0.7 percent thoria.

BROWN BEAR CLAIM

The Brown Bear claim is between North and South Frying Pan Creeks, about 2,000 feet southwest of their junction, in sec. 28, T. 10 S., R. 15 W., Principal meridian, in Beaverhead County, Mont. The claim was located in 1949 by R. A. Wellborn and associates of Armstead, Mont., and during the fall of 1950 was being leased by the Elkhorn Mining Company of Boulder, Mont. One bulldozer trench has been made across the vein.

A radioactive quartz-hematite vein on the Brown Bear claim cuts pre-Cambrian micaceous argillite and interbedded fine-grained sandstone. The dark-gray and red banded sandstone in the area between North and South Frying Pan Creeks strikes N. 12°–46° W., and dips 24° to 60° NE.

The quartz-hematite vein, which strikes N. 72° W. and dips 88° SW., is exposed in an outcrop and in the bulldozer trench, 550 feet to the southeast. It is 10 inches thick in the trench and 3 feet thick in the outcrop. The vein is tan to reddish brown and is composed of iron-stained fractured quartz cut by specular hematite veinlets. Small cavities in the quartz contain plates of specular hematite and hydrous iron oxide coatings.

Kiyoko Onoda of the Geological Survey examined a selected sample from the vein and found thorite and possibly secondary thorium oxides to be the chief radioactive minerals. Spectrographic analyses of the heavy minerals did not show any rare-earth elements or uranium.

A chip sample across the Brown Bear outcrop contains 0.017 percent equivalent uranium and 0.001 percent uranium. This sample is calculated to contain about 0.1 percent thoria. A selected sample from the bulldozer trench analyzed by Onoda was made up of 30 percent heavy minerals and 70 percent light minerals, containing 2.9 percent and 0.54 percent equivalent uranium, respectively. The bulk sample is calculated to contain 1.25 percent equivalent uranium. If it is assumed that the uranium content is negligible, the sample is calculated to contain 6.9 percent thoria. The average thoria content of the vein is believed to be somewhat higher than 0.1 percent and considerably less than 6.9 percent.

LAST CHANCE AND SHADY TREE CLAIMS

The contiguous Last Chance and Shady Tree claims are between North and South Frying Pan Creeks in secs. 21 and 28, T. 10 S., R. 15 W., Principal meridian. The two unpatented claims are owned by R. A. Wellborn of Armstead, Mont., and are under lease by the Elkhorn Mining Company of Boulder, Mont. Two bulldozer cuts, a 6-foot prospect pit, and several small pits have been made on the property.

The claims are on a radioactive vein cutting fine-grained micaceous sandstone and argillite of the pre-Cambrian Belt series. Country rock outcrops are sparse in the area, as shown in figure 47. Light-gray to green micaceous sandstone crops out on a small knob northeast of the northernmost surface exposure of the vein, and has poorly-defined bedding which strikes N. 37° W. and dips 40° NE. This sandstone is cut by many small quartz veins from $\frac{1}{16}$ to 1 inch wide. Sandstone beds strike N. 45° E. and dip 18° NW. in the prospect pit, where they apparently have been tilted. Jointing is well developed in the sandstone, the two most conspicuous systems striking N. 50° W. and N. 80° E. and dipping 87° NE. and 83° SE., respectively.

The two radioactive vein outcrops, 120 feet and 455 feet long are separated by a 235-foot interval of soil cover, as shown in figure 49 The large prospect pit exposes a vein similar in attitude and composition to the vein cropping out to the south of it, and which, if part of this vein, indicates an 80-foot extension and a northward thinning of the vein.

The south vein segment strikes generally N. 50° W. and dips 50° SW., where it is exposed in the upper bulldozer cut. It swings abruptly eastward at the north end, and is exposed in the large prospect pit where vein material strikes N. 40° W. and dips 71° SW.

The north vein segment trends N. 15° E. and is lenticular in surface exposure, pinching at the south end. This segment is believed to represent the northward extension of the south segment, although

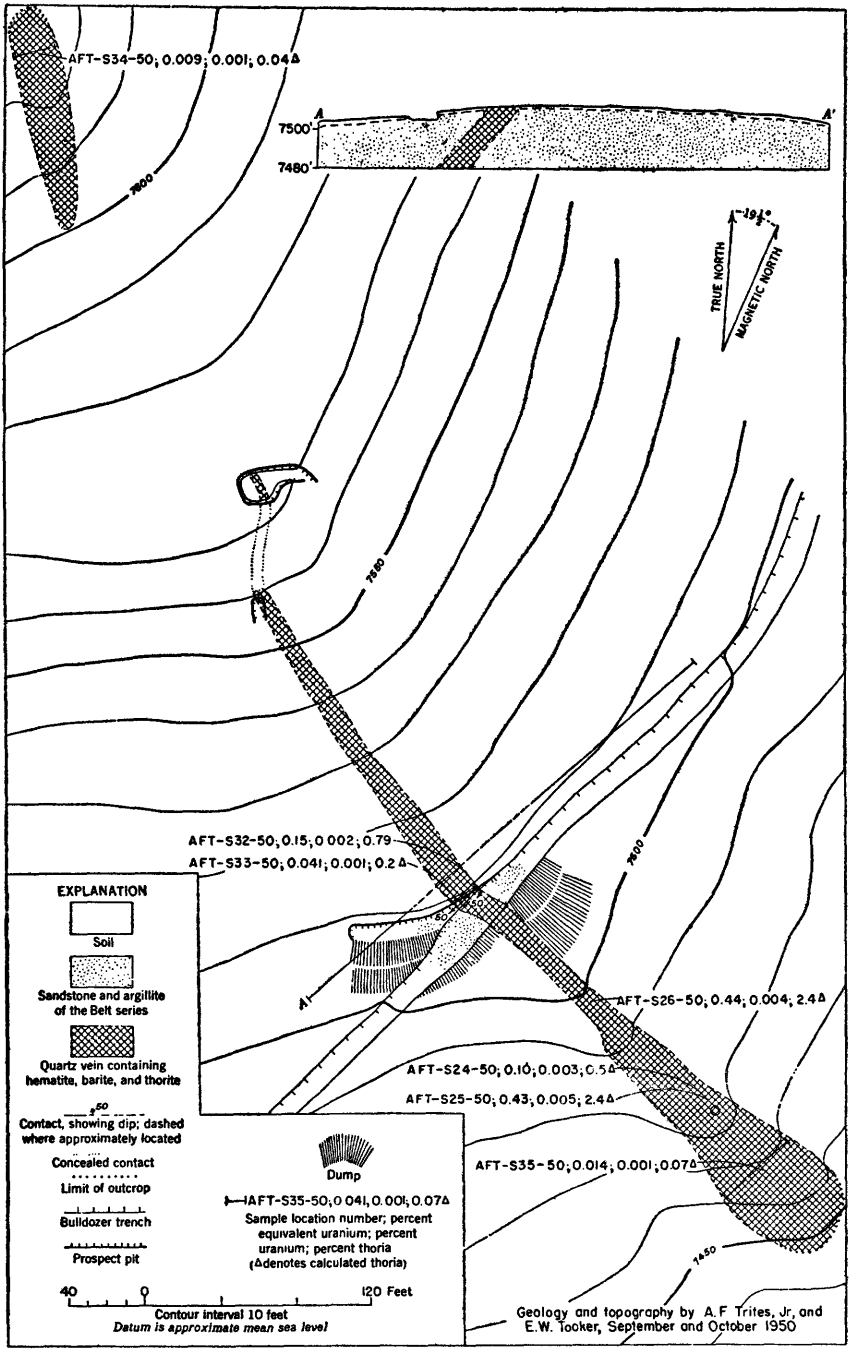


FIGURE 49.—Geologic map and sections of the Last Chance and Shady Tree claims, Beaverhead County, Mont.

it is dissimilar in trend and mineral composition, because one piece of float similar to the south vein segment was found midway between the north outcrop and the prospect pit. Float similar to the south vein segment also occurs northwest of the north outcrop on the timbered slope overlooking North Frying Pan Creek. It extends for several hundred feet down the slope from a point 100 feet below the divide, and is alined northwest along the projected trace of the vein. The vein ranges in width from 3 feet in the large prospect pit to 50 feet near the south end of the outcrop.

The south vein segment is composed of gray to pink quartz, barite, and thorite, cut by many veinlets of specular and red, earthy hematite, and hydrous iron oxides. Part of the vein is cellular, and small cavities are lined with bright, specular hematite crystals that are in many places partly coated with goethite. Barite crystals, less than 0.5 mm in size, occur throughout the vein. The thorite is in irregular masses and distinct crystals throughout the vein. Subhedral and anhedral thorite crystals are altered to hematite and goethite along distinct basal cleavage planes. Thorite crystals form 10 percent of some specimens and appear to be associated with red hematite.

An older coarse-grained quartz is cemented by a younger finer-grained quartz. The general mineral sequence is believed to have been quartz, barite, thorite, quartz, chalcedony, goethite, earthy hematite, specular hematite, and goethite.

A selected sample from the south outcrop, analyzed spectrographically for rare earths, calcium, barium, and strontium by Tennyson Myers of the Geological Survey Trace Elements Section Denver Laboratory, contains 0.0X percent yttrium, 0.0X percent lanthanum, 0.X percent neodymium, 0.0X percent calcium, 0.X percent barium, and 0.00X percent strontium. Neodymium has not been found in thorite from the Trapper no. 1 and the Brown Bear claims, and the mineral or minerals containing it have not been determined.

The vein material from the north outcrop consists of barite, quartz, minor quantities of hematite, goethite, chalcedony, and scattered crystals of thorite. White barite crystals, 0.5 mm across, and quartz are cut by specular and red, earthy hematite veinlets, as much as 1.0 mm thick, which have an inner rim of goethite and an outer rim of chalcedony. Chalcedony cements quartz fragments along the borders of hematite veinlets, and is locally cut by hematite. Goethite pseudomorphs after a rhombohedral mineral, ½ to ¾ inch across, that may have been siderite or ankerite were found on the dump of the large prospect pit.

Most of the abnormal radioactivity is believed to be from thorite and possibly a secondary hydrate of thorium. The content of equivalent uranium, uranium, and thoria in samples from the Last Chance and Shady Tree claims is shown in table 11. Samples from the south outcrop contain from 0.07 to 2.4 percent thoria. A sample from the 5-foot footwall part of the vein exposed in the bulldozer cut contains 0.8 percent thoria, whereas one from the hanging-wall part contains 0.2 percent thoria.

The grade of the sample from the north segment is considerably lower, about 0.04 percent thoria and 0.001 percent uranium.

TABLE 11.—*Equivalent uranium, uranium, thoria, and calculated thoria, in percent, Last Chance and Shady Tree claims, Beaverhead County, Mont.*

Sample no.	Location	Description	Equivalent uranium	Uranium	Thoria	Calculated thoria
AFT-S24-50	Small pit, southern segment.	Chip sample across cherty lens.	0.10	0.003		0.5
AFT-S25-50	do	1-foot chip sample of vein	.43	.005		2.4
AFT-S26-50	South segment below bulldozer trench.	do	.44	.004		2.4
AFT-S32-50	Bulldozer trench	5-foot chip sample across footwall of vein.	.15	.002	0.79	.8
AFT-S33-50	do	Chip sample across hanging wall of vein.	.041	.001		.2
AFT-S34-50	Northern segment	Chip sample across vein	.009	.001		.04
AFT-S35-50	South end, south segment.	do	.014	.001		.07

REFERENCES

Anderson, A. L., 1942, Endomorphism in the Idaho batholith: Geol. Soc. America Bull., vol. 53, no. 8, pp. 1099–1126.

——— 1943, A preliminary report on the cobalt deposits in the Blackbird district, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 61, 34 pp.

——— 1947, Role of the Idaho batholith during the Laramide orogeny (Abst.): Geol. Soc. America Bull., vol. 58, no. 12, p. 1162.

Anderson, A. L., and Wagner, W. R. T., 1944, Lead-zinc-copper deposits of the Birch Creek district, Clark and Lemhi Counties, Idaho: Idaho Bur. Mines and Geology Pamph. 70, 43 pp.

Condit, D. D., 1918, Relations of late Paleozoic and early Mesozoic formations of southwestern Montana and adjacent parts of Wyoming: U. S. Geol. Survey Prof. Paper 120.

Dana, E. S., 1920, A system of mineralogy, 6th ed.

George, D. R., 1951, Thorite from California, a new occurrence and variety: Am. Mineralogist, vol. 36, nos. 1 and 2, pp. 129–132.

Hess, F. L., 1921, Cobalt: Mineral resources U. S., 1917, pt. 1, pp. 899–901.

Huttl, J. B., 1950, Howe Sound's cobalt mine rapidly nearing completion: Eng. and Min. Jour., vol. 151, no. 10, pp. 89–91.

Hutton, C. O., 1950, Studies of heavy detrital minerals: Geol. Soc. America Bull., vol. 61, no. 7, pp. 635–716.

Kirkham, V. R. D., 1927, A geologic reconnaissance of Clark and Jefferson and parts of Butte, Custer, Fremont, Lemhi, and Madison Counties, Idaho· Idaho Bur. Mines and Geology Pamph. 19, 47 pp.

Klepper, M. R., 1951, A geologic reconnaissance of parts of Beaverhead and Madison Counties, Mont.: U. S. Geol. Survey Bull. 969–C.

Mansfield, G. R., 1920, Coal in eastern Idaho: U. S. Geol. Survey Bull. 716, pp. 123–153.

Reed, G. C., and Herdlick, J. A., 1947, Blackbird cobalt deposits, Lemhi County, Idaho: U. S. Bur. Mines Rept. Inv. 4012, 14 pp.

Roberts, W. A., and Gude, A. J., Uranium-bearing deposits west of Clancey area, Jefferson County, Mont.: U. S. Geol. Survey Bull. (in preparation).

——— Geology of the area adjacent to the Free Enterprise uranium-silver mine, Boulder district, Jefferson County, Mont.: U. S. Geol. Survey Bull. (in preparation).

Sahinen, U. M., 1939, Geology and ore deposits of the Rochester and adjoining mining districts, Madison County, Mont.: Montana Bur. Mines and Geology Mem. 19, 53 pp.

Scott, H. W., 1939, Some carboniferous stratigraphy in Montana and northwestern Wyoming: Jour. Geology, vol. 43, no. 8, pp. 1011–1032.

Shenon, P. J., 1928, Geology and ore deposits of the Birch Creek district, Idaho: Idaho Bur. Mines and Geology Pamph. 27, 25 pp.

Sloss, L. L., 1950, Paleozoic sedimentation in Montana area: Am. Assoc. Petroleum Geologists Bull., vol. 34, no. 3, pp. 423–451.

Sloss, L. L., and Hamblin, R. H., 1942, Stratigraphy and insoluble residues of Madison group (Mississippian) of Montana: Am. Assoc. Petroleum Geologists Bull., vol. 26, no. 3, pp. 305–335.

Stearns, H. T., Crandall, L., and Steward, W. G., 1938, Geology and groundwater resources of the Snake River plain in southeastern Idaho: U. S. Geol. Survey Water-Supply Paper 774.

Thurlow, E. E., and Wright, R. J., 1950, Uraninite in the Coeur d'Alene district, Idaho: Econ. Geology, vol. 45, pp. 395–404.

Umpleby, J. B., 1913, Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528.

——— 1917, Geology and ore deposits of the MacKay region, Idaho: U. S. Geol. Survey Prof. Paper 97.

Wilson, R. A., 1937, Sedimentary gneisses of the Salmon River region near Shoup, Idaho: Jour. Geology, vol. 45, no. 2, pp. 193–203.

Winchell, A. N., 1914, Mining districts of the Dillon quadrangle, Montana and adjacent areas: U. S. Geol. Survey Bull. 574.

APPENDIX

GEOLOGIC LOGS OF DIAMOND-DRILL HOLES ON THE TRAPPER CLAIMS, LEMHI PASS DISTRICT, IDAHO AND MONTANA

Trapper no. 1 claim, hole no. 1

Altitude of collar — 7,165.9 ft, bearing — N. 80° W., inclination — 45°, total depth — 68.0 ft.

	Thickness (feet)	Depth (feet)
Sandstone, light gray to light greenish gray, micaceous	16.5	16.5
Quartz veinlet, brecciated, limonite	¼ (in.)	16.5+
Sandstone, light greenish gray, micaceous	3.8−	20.3
Sandstone, light greenish gray; cut by hematite-coated fractures	3.0+	23.3+
Quartz vein, reddish brown	1.7−	25.0
Sandstone, grayish green, micaceous	1.0	26.0
Fracture, limonite coated		26.0
Sandstone, grayish green, micaceous	9.0	35.0
Sandstone, grayish green, micaceous; cut by limonite-coated fractures	1.5	36.5
Sandstone, grayish green, micaceous	3.5	40.0
Sandstone, dark grayish green, very fine grained; brecciated	.5	40.5
Sandstone, dark grayish green, very fine grained	.5	41.0
Quartz vein, gray	⅜ (in.)	41.0+
Sandstone, dark grayish green, very fine grained	2.0−	43.0
Sandstone, dark grayish green, very fine grained; brecciated	.5	43.5
Sandstone, cut by many limonite and hematite-coated fractures	4.5	48.0
Sandstone, light gray, micaceous	1.0	49.0
Sandstone, light gray, micaceous, fractured	.25	49.25
Sandstone, light gray, micaceous	1.75	51.0
Quartz vein, gray	½ (in.)	51.0+
Sandstone, gray, very fine grained	1.0−	52.0
Fracture zone, containing limonite and quartz	.3	52.3
Sandstone, gray, very fine grained	.2	52.5
Sandstone, gray, very fine grained; brecciated and limonite coated	1.5	54.0
Sandstone, light gray, micaceous; cut by small limonite- and hematite-coated fractures	14.0	68.0
Bottom of hole		68.0

Trapper no. 1 claim, hole no. 2

Altitude of collar 7,155.2 ft. bearing N. 82½° W., inclination 60°, total depth 138.5 ft.

	Thickness (feet)	Depth (feet)
Quartz-hematite-thorite vein; extremely brecciated	14.5	14.5
Sandstone, gray to pale green, fine grained; cut by veinlets of pale gray quartz	7.0	21.5
Sandstone, gray to green; fractured	.6	22.1
Sandstone, yellow to green; cut by thin veinlets of pale pink aplite	.6	22.7
Quartz-hematite-thorite vein	.3	23.0
Sandstone, buff, pale green, and dark gray, fine grained, micaceous	9.6	32.6
Quartz veinlet, light gray; cut by red hematite streaks	1½ (in.)	32.6+
Sandstone, light to dark gray, micaceous; cut by veinlets of aplite	17.9−	50.5
Quartz-hematite-thorite vein, reddish brown	.5	51.0
Sandstone, gray to green, micaceous; cut by veinlets of quartz, 1/16 to 1 inch wide	5.5	56.5
Sandstone, brecciated	1.0	57.5
Sandstone, light gray, micaceous; cut by veinlets of white clay; extremely fractured	1.5	59.0
Sandstone, light gray, micaceous	9.5	68.5
Siltstone, very light gray to white; slightly fractured and limonite coated	.5	69.0
Sandstone, brecciated, silicified (?) and limonite coated	2.5	71.5
Sandstone, dark to light gray; cut by many small limonite-coated fractures	2.0	73.5
Sandstone, dark gray, micaceous; extremely brecciated and limonite coated	5.0	78.5
Fracture zone, containing sandstone breccia	5.0	83.5
Argillite, pink to red	2.0	85.5
Sandstone, light gray, micaceous, and thin beds of gray argillite; fractured	53.0	138.5
Bottom of hole		138.5

Trapper no. 1 claim, hole no. 3

Altitude of collar 7,155.2 ft, bearing due N., inclination 45°, total depth 49.0 ft.

	Thickness (feet)	Depth (feet)
Sandstone, white, fine grained, and argillite; contains limonite	2.8	2.8
Quartz-hematite-thorite vein, reddish brown, radioactive	5.5	8.3
Sandstone, grayish brown; altered, containing limonite and clay	.5	8.8
Sandstone, gray to green, very fine grained; fractured	2.7	11.5
Sandstone, brecciated, containing much limonite	12.0	23.5
Sandstone, dark gray	3.5	27.0
Sandstone, brecciated	1.5	28.5
Sandstone, gray, micaceous	6.0	34.5
Sandstone, gray, micaceous; brecciated	4.5	49.0
Bottom of hole		49.0

INDEX